

SERVICE MANUAL

MODEL
TTM50A-A7



by KANZAKI

Code : M2-77623-0020

INTRODUCTION

This manual gives specific instructions for the proper repair on TTM transmissions.

Please follow the procedures carefully to insure quality service.

KANZAKI recommends that you read the manual completely before starting with repairs, as some of the procedures described are rather complex.

Along with standard tools, KANZAKI recommends the use of special tools, necessary to perform repairs correctly.

This manual is based on the technical information at the time of printing. The manual has been checked carefully in order to avoid errors. However KANZAKI is not liable, for any misrepresentations, errors of description or omissions.

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1. To Perform Service Safely

1.1. Warning Symbols

- Most accidents are caused by negligence of basic safety rules and precautions.
For accident prevention, it is important to avoid such causes before development to accidents.
Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures.
Attempting a repair or maintenance job without sufficient knowledge may cause an unexpected accident.
- It is impossible to cover every possible danger in repair or maintenance in the manual. Sufficient consideration for safety is required in addition to the matters marked  **CAUTION**. Especially for safety precautions in a repair or maintenance job not described in this manual, receive instructions from a knowledgeable leader.
- Warning Symbols used in this manual and their meanings are as follows :



DANGER-Indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.



WARNING-Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.



CAUTION-Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

- Any matter marked **[NOTICE]** in this manual is especially important in serving. If not observed, the product performance and quality may not be guaranteed.

1.2. Precaution for Safe Servicing

(1) Service Shop (Place)

⚠ CAUTION

● **Sufficiently wide and flat place**

The floor space of the service shop for inspection and maintenance shall be sufficiently wide and flat without any hole.

[Otherwise]

An accident such as a violent fall may be caused.

⚠ CAUTION

● **Clean, orderly arranged place**

No dust, mud, oil or parts shall be left on the floor surface.

[Otherwise]

An unexpected accident may be caused.

⚠ CAUTION

● **Bright, safety illuminated place**

The working place should be illuminated sufficiently and safely.

For a job in a dark position involving difficulty in observation, use a portable safety lamp. The bulb shall be covered with a wire cage.

[Otherwise]

The bulb may be broken accidentally to cause ignition of leaking oil.

⚠ CAUTION

● **Place equipped with a fire extinguisher**

Keep a first aid kit and fire extinguisher close at hand in preparation for an emergency of fire.

(2) Working Wear

⚠ CAUTION

● **Wears for safe operation**

Wear a helmet, working clothes, safety shoes and other safety protectors matching each job. Especially, wear well-fitting working clothes.

[Otherwise]

A serious accident such as trapping by a machine may arise.

(3) Tools to Be Used

⚠ WARNING

● **Appropriate holding and lifting**

Never operate when the marine gear is supported with blocks or wooden pieces or only with a jack. To lift and hold the marine gear, always use a crane with a sufficient allowance in limit load or a rigid jack.

[Otherwise]

A serious accident may arise.

⚠ WARNING

● **Use of appropriate tools**

Use tools matching the jobs to be done. Use a correctly sized tool for loosening or tightening a machine part.

[Otherwise]

A serious injury or marine gear damage may arise.

(4) Use of Genuine parts, Oil and Grease

⚠ CAUTION

● **Always use genuine product**

[Otherwise]

Shortening of marine gear life or an unexpected accident may arise.

(5) Bolt and Nut Tightening Torques

⚠ WARNING

● **Always tighten to the specified torque if designated in the manual**

[Otherwise]

Loosening or falling may cause parts damage or an injury.

(6) Handling Of Product

⚠ WARNING



● **Pay attention to hot portions**

Do not touch the engine or marine gear during running or immediately after it is stopped

[Otherwise]

Scalding may be caused by a high temperature.

(7) Waste Disposal

⚠ CAUTION

Observe the following instructions with regard to waste disposal. Negligence of each instruction will cause environmental pollution.

- Waste fluids such as engine and marine gear oil and cooling water shall be discharged into a container without spillage onto the ground.
- Do not let waste fluids be discharged into the sewerage, a river or the sea.
- Harmful wastes such as oil, fuel, coolants, solvents, filter elements and battery shall be disposed according to the relevant laws and regulations. Ask a qualified disposal company for example.

2. General

2.1. Construction

This marine gear has a built-in wet type multi-disc clutch and is operated by the oil pressure of the hydraulic pump. It is composed of the damper, input shaft, reduction gear, clutch, oil pump and the case. The lube oil for each of the parts is distributed by the oil pump in a forced lubrication system.

When the forward/reverse changing valve lever is moved, oil pressure is applied to move the clutch to the forward or reverse position.

The clutch for c.w. rotation of O/P is fitted to the input shaft, and the clutch for c.c.w. rotation of O/P is fitted to the support shaft.

The gear oil(lube oil) is cooled by a multi-pipe seawater cooler.

2.2 Specifications

ITEMS			SPECIFICATION	REMARKS
TYPE			DOWN ANGLE HYDRAULIC	
ANGLE	DEG.		8	
MAX.INPUT TORQUE	N·m		660	
INPUT SPEED	min ⁻¹		700~3800	
REDUCTION RATIO (F/R)			2.43/2.43	
			2.13/2.13	
			1.67/1.67	
DIRECTION OF ROTATION	I/P		C.C.W	VIEWED FROM STERN
	O/P		C.W. or C.C.W.	
SHIFT			MECHANICAL CABLE	
LUBRICATION			FORCED LUBRICATION	
OIL QTY.(EFFECTIVE)	L		2.0(0.4)	
DIMENSION	L	mm	250	WITH B/W BELL HOUSING
	A	mm	132	
	W	mm	350	
BELL HOUSING SIZE			B/W	
CLUTCH SIZE			SAE 11 ¹ / ₂ "	
DRY MASS	MARINE GEAR	kg	43	

2.3. Power transmission system

•Power transmission process at shift lever position A

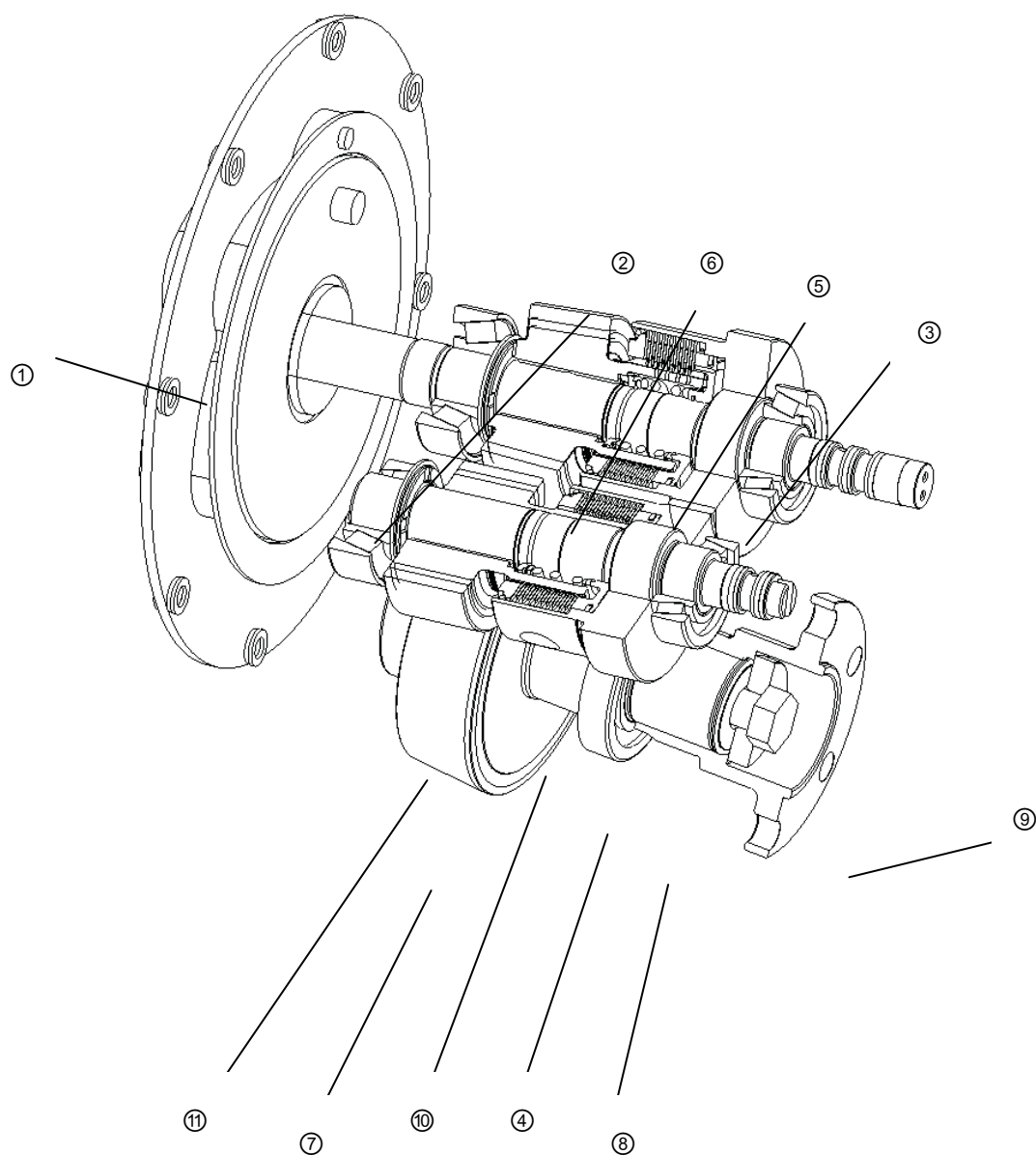
Damper ① → Input shaft ② → Drive gear ③ → Input shaft clutch ⑤ → Input pinion ⑥ → →

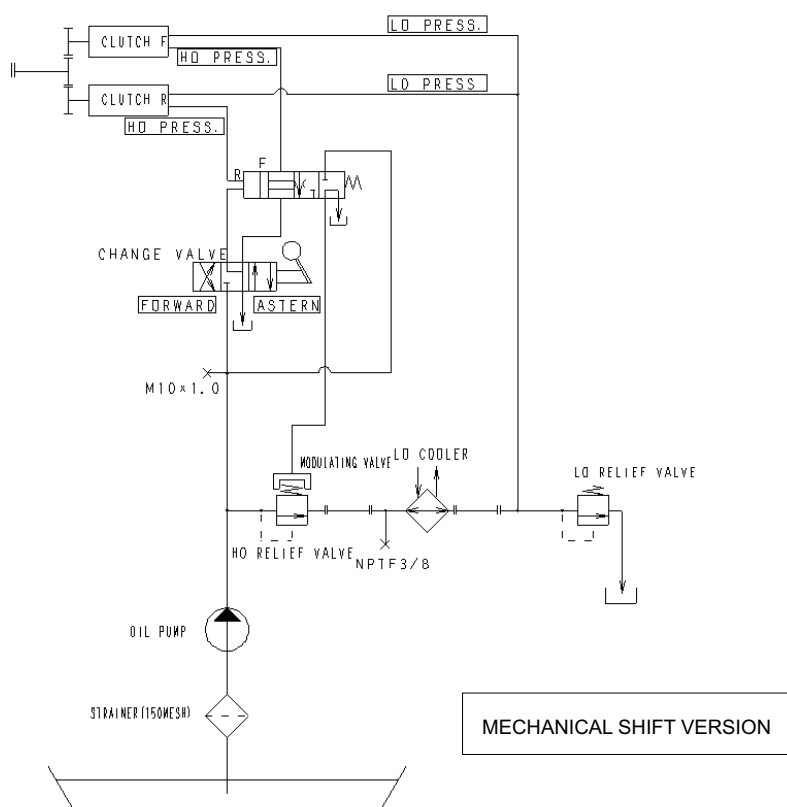
Output gear ⑦ → Output shaft ⑧ → Output coupling ⑨

•Power transmission process at shift lever position B

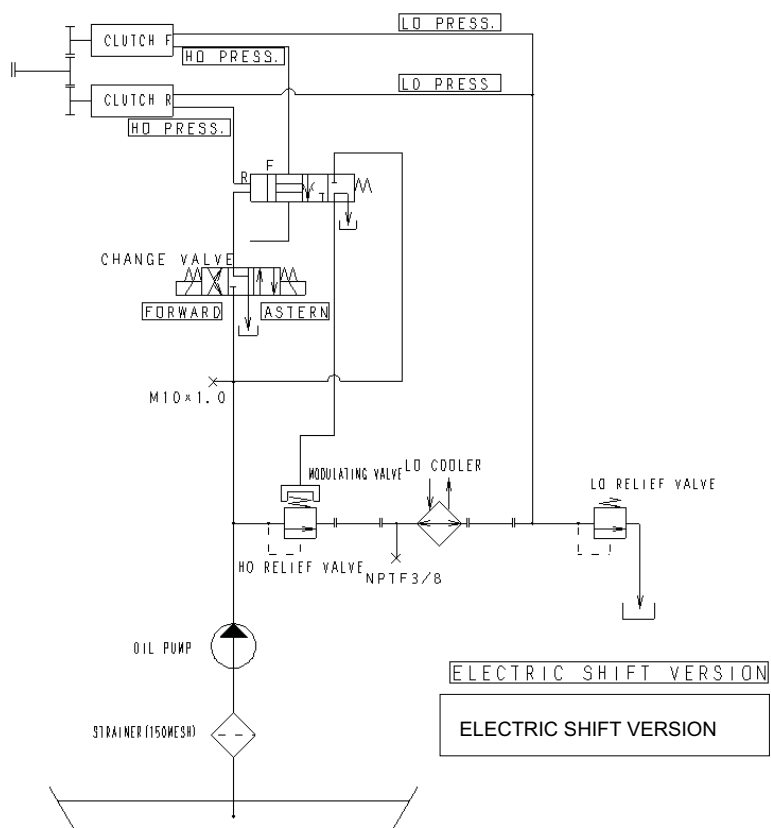
Damper ① → Input shaft ② → Drive gear ③ → Driven gear ④ → Support shaft clutch ⑩ →

→ Support pinion ⑪ → Output gear ⑦ → Output shaft ⑧ → Output coupling ⑨



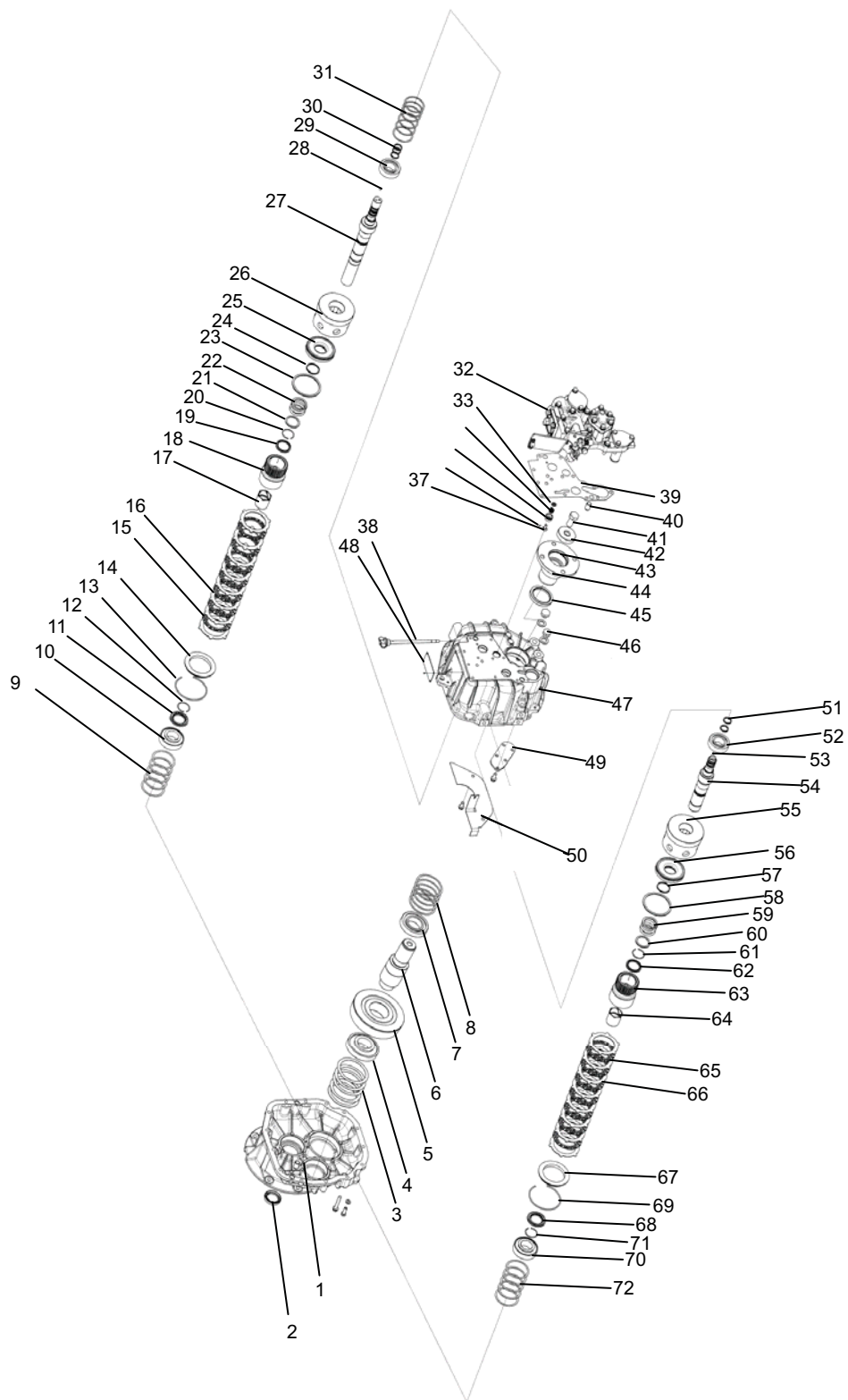


2.4. Hydraulic diagram

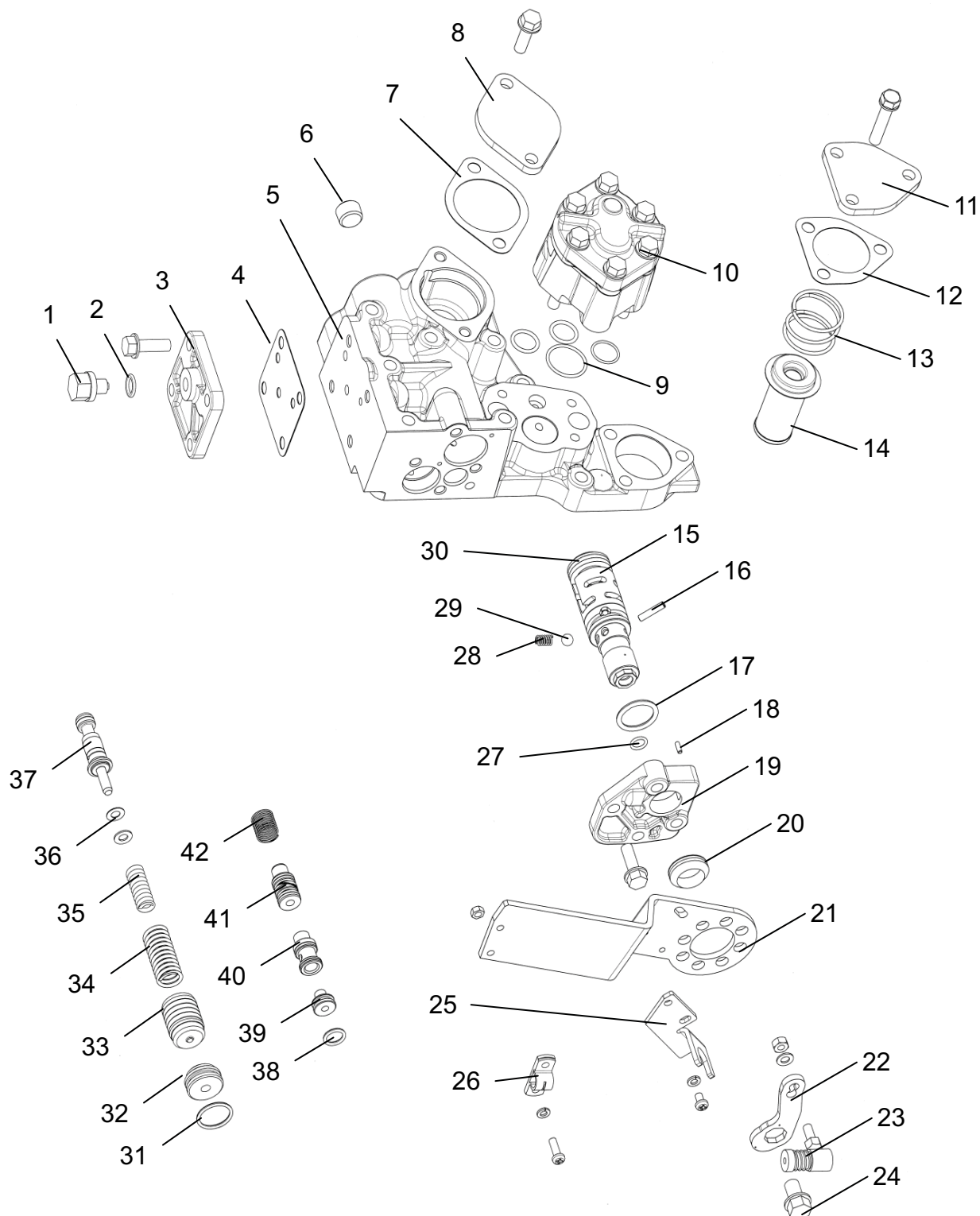


• mark × : pressure gauge position (hydraulic/lubrication oil)

2.5. Drawing

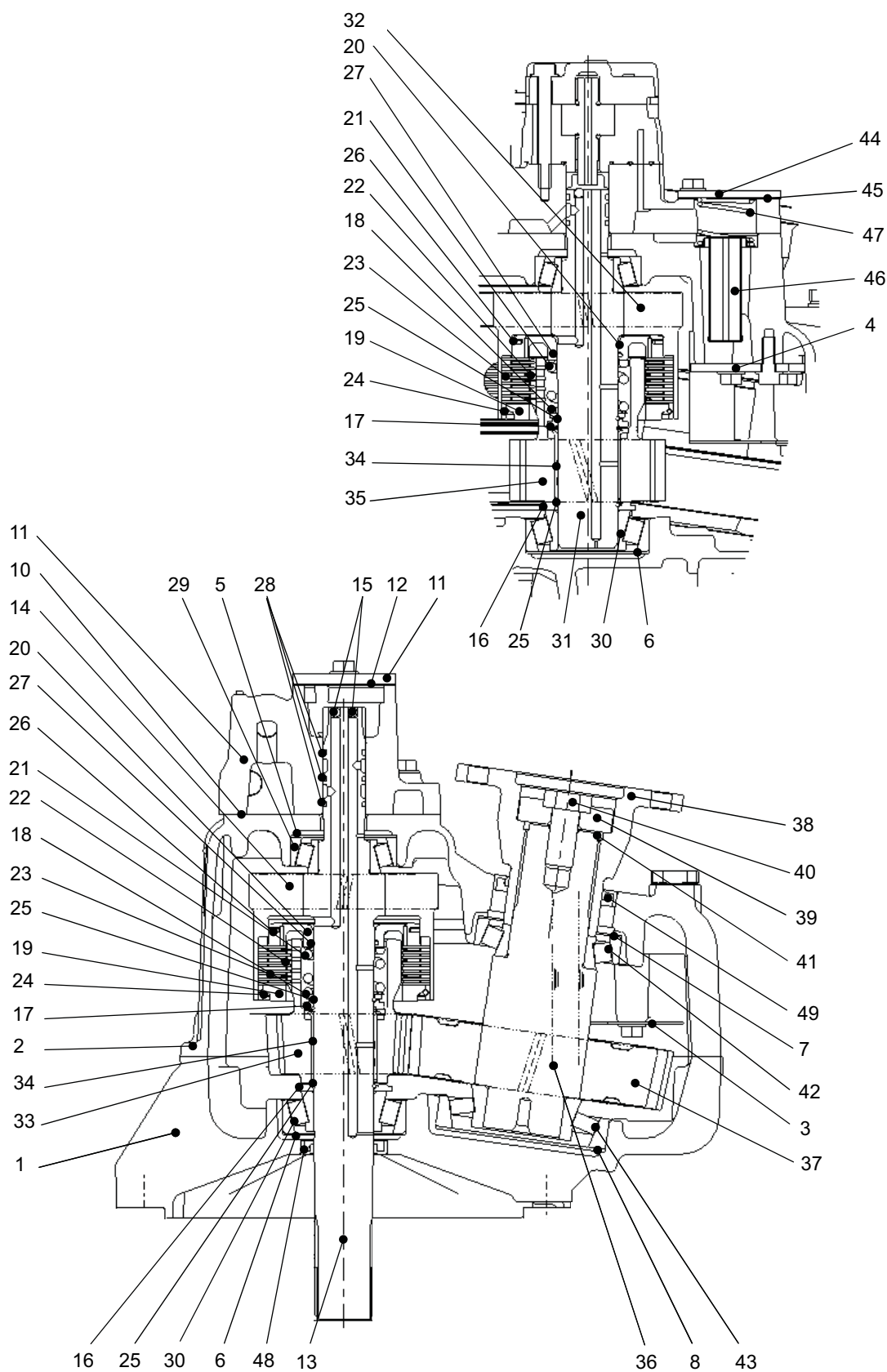


1-Case A	25-Hydraulic Cylinder	49- Cover Suction
2-Oil Seal	26-Drive Gear	50- Baffle Plate
3-Shims(0.3,0.4,0.5,0.8)	27-Input Shaft	51-Seal Ring
4-Bearing	28-Ball	52- Bearing
5-Output Gear	29-Bearing	53- Ball
6-Output Shaft	30-Seal Ring	54- Support Shaft
7-Bearing	31-Shims(0.3,0.4,0.5)	55- Driven Gear
8-Shims(0.2,0.25,0.3,0.35,0.5)	32-Case Plate	56- Hydraulic Cylinder
9-Shims(0.1,0.3,0.5,1.0)	33-Spring Retainer	57- Ring
10-Bearing	34-2 nd Relief Seat	58- Ring
11-Thrust Collar	35-Spring	59- Spring
12-Ring	36-Spring Pin	60- Spring Retainer
13-Ring	37-2 nd Relief Valve	61- Ring
14-Friction Disc Retainer	38- Dipstick	62- Thrust Collar
15-Friction Disc	39- Gasket	63- Support Pinion
16-Steel Plate	40- Parallel Pin	64- Bushing
17-Bushing	41- Bolt	65- Friction Disc
18-Input Pinion	42- Coupling Plate	66- Steel Plate
19-Thrust Collar	43- O-ring	67- Friction Disc
20-Ring	44- Output Coupling	68- Thrust Collar
21-Spring Retainer	45- Oil Seal	69- Ring
22-Return Spring	46- Plug	70- Bearing
23-Ring	47- Case B	71- Ring
24-Ring	48- Name Plate	72- Shims(0.1,0.3,0.5,1.0)

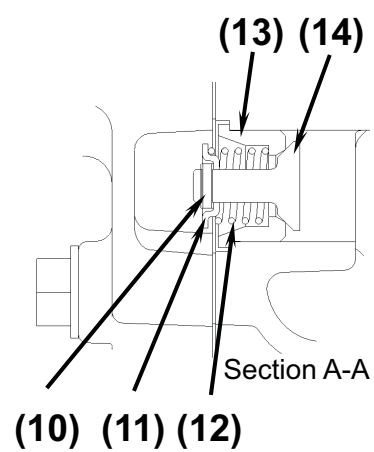
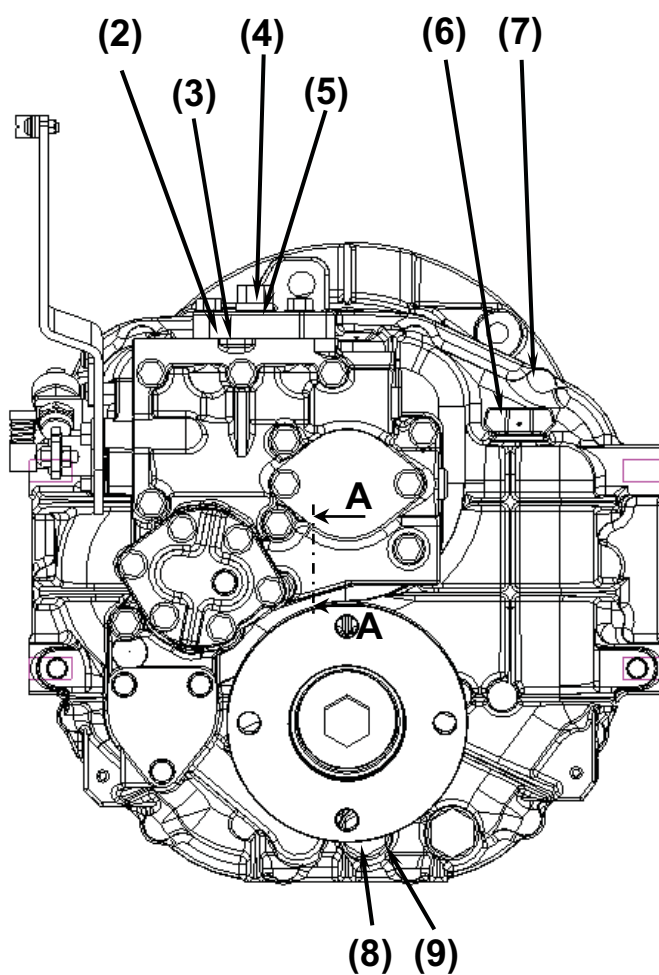
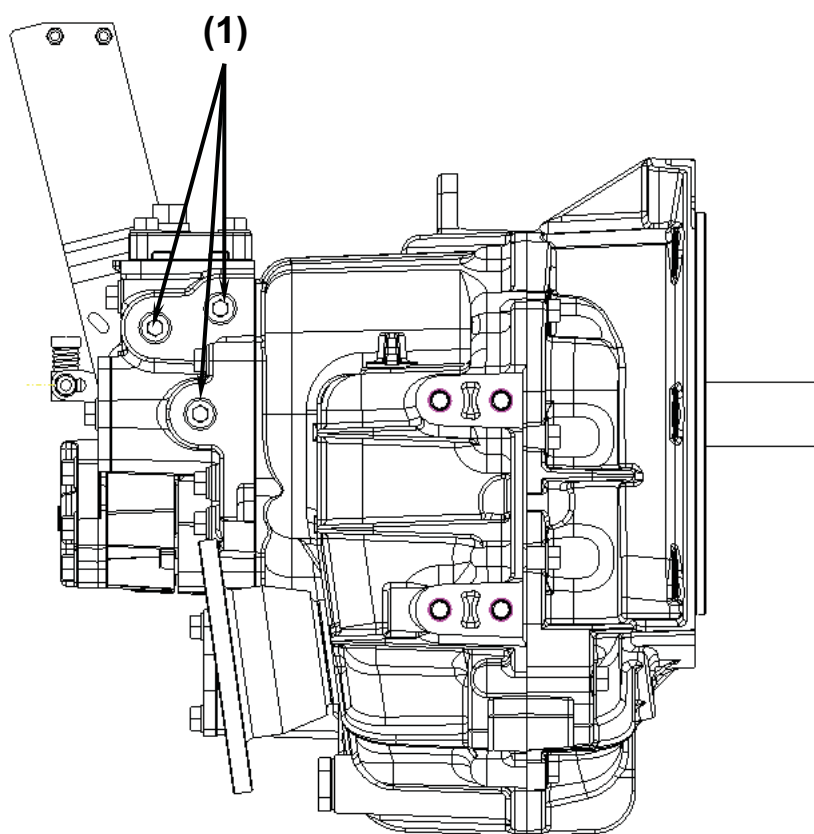


1-Plug	22-Shifting Lever
2-O-ring	23-Ball Joint
3-Upper Cover	24-Bolt
4-Gasket	25-Switch Support
5-Case Plate	26-Clamp
6-Plug	27-O-ring
7-Gasket	28-Bolt
8-PTO Cover	29-Ball
9-O-ring	30-Seal Ring
10-Hydraulic Pump	31-O-ring
11-Strainer Cover	32-Cover
12-Gasket	33-Modulating Valve
13-Strainer Spring	34-Spring
14-Filter	35-Spring
15-Shifting Valve	36-Shim
16-Pin	37-HO Relief Valve
17-O-ring	38-O-ring
18-Pin	39-Cover
19-Cover	40-Pilot Valve
20-V-ring	41-Throttle Valve
21-Wire Bracket	42-Spring

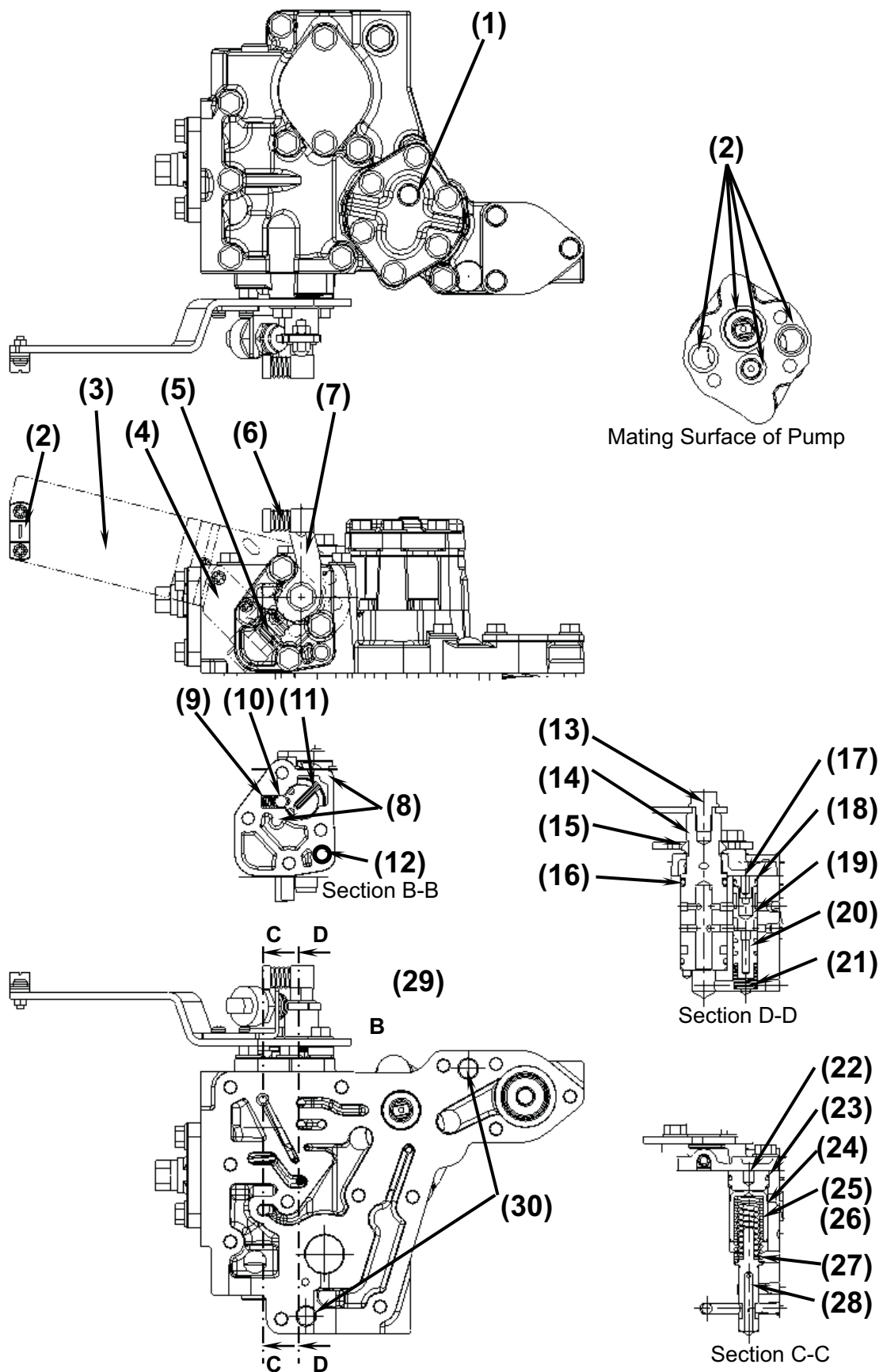
2.6 Sectional View



1-Case A	26- Ring
2-Case B	27-Ring
3-Baffle Plate	28-Ring
4-Suction Cover	29-Bearing
5-Shim	30-Bearing
6-Shim	31-Support Shaft
7-Shim	32- Driven Gear
8-Shim	33-Input Pinion
9-Case Plate	34- Bushing
10- Gasket	35-Support Pinion
11- PTO Cover	36-Output Shaft
12-Gasket	37-Output Gear
13- Input Shaft	38-Output Coupling
14- Drive Gear	39-Coupling Plate
15- Ball	40-Bolt
16- Thrust Collar Eng.	41-O-ring
17- Thrust Collar Prop.	42-Bearing
18- Spring Retainer	43-Bearing
19- Friction Disc Retainer	44-Strainer Cover
20- Hydraulic Cylinder	45-Gasket
21- Return Spring	46-Filter
22- Friction Disc	
23- Steel Plate	
24- Ring	
25- Ring	



- | | |
|---------------------------|---------------------------------|
| 1- Plug | 9- Seal Washer |
| 2- Upper Cover | 10- Spring Pin |
| 3- Gasket | 11- Spring Retainer |
| 4- Plug | 12- Spring |
| 5- O-ring | 13-2 nd Relief Sheet |
| 6- Dipstick with Breather | 14-2 nd Relief Valve |
| 7- Parallel Pin | |
| 8- Magnet Plug | |



1-Pump	16-O-ring
2-Clamp	17-Cover
3-Wire Bracket	18-O-ring
4-Switch Support	19-Pilot Valve
5-Safety Switch	20-Throttle Valve
6-Ball Joint	21-Spring
7-Shifting Lever	22-Cover
8-Parallel Pin	23-O-ring
9-Spring	24-Modulating Valve
10-Ball	25-Spring
11-Pin	26-Spring
12-O-ring	27-Shim
13-Bolt	28-HO Relief Valve
14-Shifting Valve	29-Cover
15-V-ring	30-Parallel Pin

3. Overhaul

3.1. Precautions

(1) For Safe Operation

Read the safety precautions at the beginning of this manual carefully and operate safely.

(2) Past Inspections for the Engine and the Marine Gear

For precise, high-quality operation, preparation is necessary. Check the customer management file for the past performance of the engine and marine gear.

- (2.1) When was the last maintenance work done?
- (2.2) How much has the marine gear been used (length of time/hrs. of use) since the last maintenance work?
- (2.3) What problems were found at the last inspection, and what maintenance work was performed?
- (2.4) Are the parts needed for replacement during maintenance on hand?
- (2.5) Is there a check sheet for the maintenance work?

(3) Preparation for Disassembly

- (3.1) Have ready all-purpose tools, special tools, gauges, grease, disposable parts, and replacement parts.
- (3.2) When disassembling complicated sections, make alignment markings which will not damage the parts but will make reassembly easier.

(4) Precautions for Disassembly

- (4.1) As each part is removed, check its condition and look for changes in shape, damage, and scratches.
- (4.2) Disassemble the parts in an orderly manner separating parts which can be reused from those which need to be replaced.
- (4.3) Clean or wash the parts to be reused thoroughly.

(5) Inspection and Measurement

- (5.1) Make the necessary inspections and measurements for parts to be reused and determine whether they are good or bad.

(6) Reassembly

- (6.1) Use the correct parts and assemble them in the correct manner to specified standards (tightening torque, adjustment values, etc.). Also, grease the important bolts and nuts as specified.
- (6.2) Be sure to use genuine parts for replacements.
- (6.3) Be sure to replace oil seals, O-rings, and packings with new ones.
- (6.4) Depending upon the placement of the packing, grease the seal packing, oil or grease moving parts, and insert grease in the lip of the oil sheet.

(7) Adjustment and Inspection

- (7.1) Use gauges and testers to adjust to the specified standard.

3.2. Preparing for Overhaul

Prepare for the disassembly and maintenance of the marine gear as follows.

- (1) Secure the marine gear on a level base.

⚠ CAUTION

*Be sure the marine gear is secured.
If the marine gear falls over during operation, injury
or damage to parts may occur.*

- (2) Drain the marine gear lube oil.
- (3) Clean off any dirt, oil, or dust on the marine gear with detergent, air, steam, etc.

[NOTICE]

Be careful not to get any dust inside the marine gear during operation.

⚠ CAUTION

*Wear goggles and protective gear when using air or steam.
Flying particles may injure the eyes.*

[NOTICE]

- Be sure to replace the parts which upon inspection and measurement are faulty, whose measurements are outside the prescribed limits, or have exceeded the prescribed period of use.
- Parts which still meet the standard measurements and prescribed period of use, but which are expected to fall below the standard before the next inspection should be replaced early.

3.3. Major components

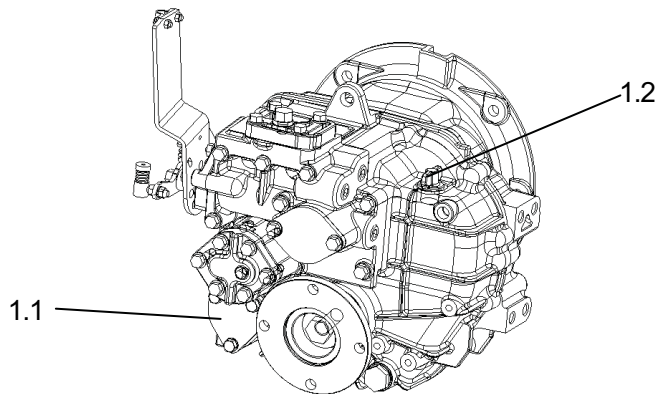
3.3.1. transmission set-up

The main components of the TTM Marine Transmissions are:

Item 1 two-piece aluminum cast

1.1 oil strainer

1.2 oil dipstick & breather

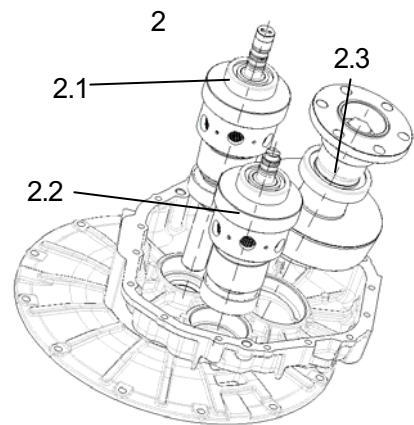


Item 2 gears

2.1 input shaft with clutch pack assembly for opposite of engine rotation

2.2 support shaft with clutch pack assembly for same as engine rotation

2.3 output shaft

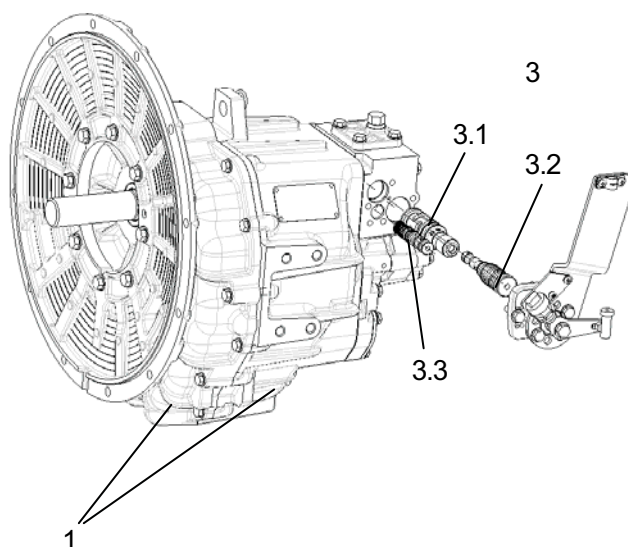


Item 3 valves

3.1 rotary valve

3.2 shifting pressure relief valve

3.3 throttle valve



3.3.2. Cleaners and sealants

For cleaning

Cold cleaner such as benzene , trichloroethane .

⚠ WARNING

Keep detergents away from your skin, do not drink and do not inhale their vapors! Always wear protective gloves and safety glasses!

Note accident prevention rules!

For assembly:

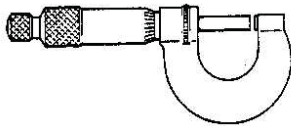
- Three bond 1215(or equivalent) for transmission housing surfaces.
- Grease: Shell Alvania Grease (or equivalent) for radial shaft seals.

3.3.3. Measuring tools

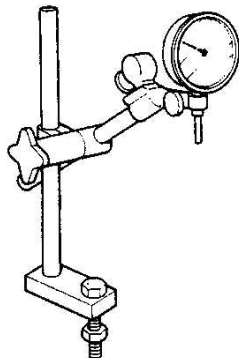
Micrometer

Measuring gauge from 0-25 mm

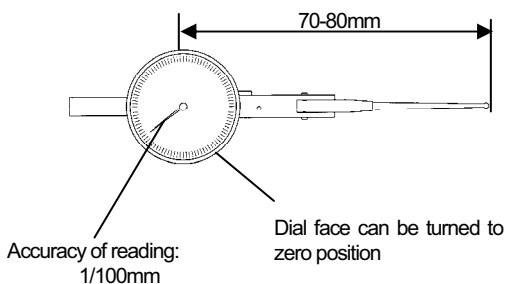
Accuracy of reading 1/100 mm



Dial indicator gauge with arm-type support



Dial gauge increments



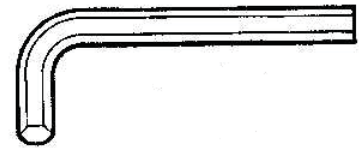
3.3.4. Standard tools and fixture

Wrench

For hexagon bolts (8mm, 12mm, 14mm, 17mm, 24mm)

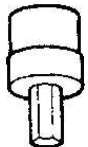
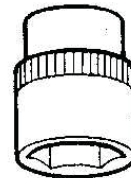


Allen wrench (6mm, 8 mm)



Hexagon socket wrench

(12mm, 13mm, 17mm, 24mm, 30mm) (6mm, 8mm)

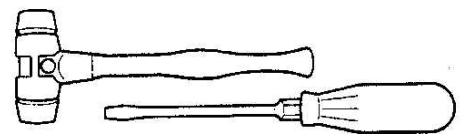


Torque wrench

Adjustable up to 450 Nm

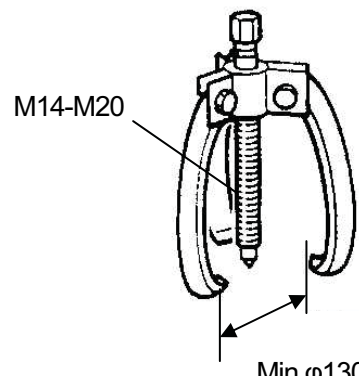


Plastic hammer (1000 g) and sturdy screwdriver



Extractor

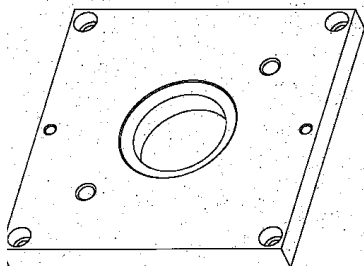
Minimum diameter 130 mm



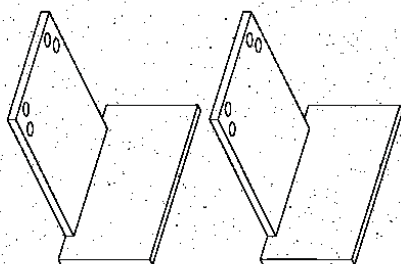
3.3.5. Special tools

BASE (Parts No.177524-09210)

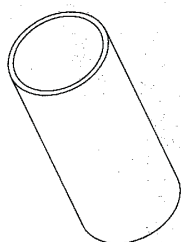
For disassembly of shaft assembly



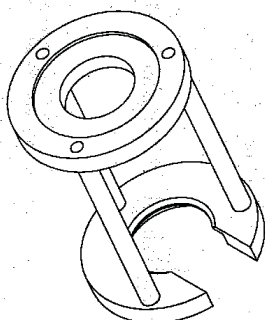
REPAIR STAND (Parts No.177524-09110)



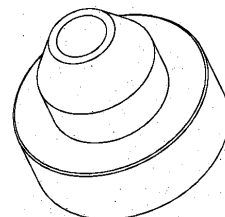
SPACER A (Parts No.177524-09320)



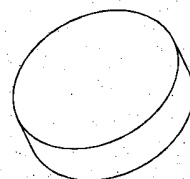
SPRING PUSHER (Parts No.177524-09310)



SHAFT STAND(Parts No.177524-09240)

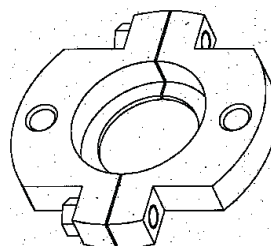


SPACER B (Parts No.177524-09330)



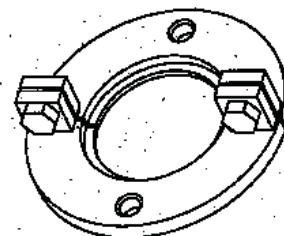
BEARING EXTRACTOR (Parts No.177523-09350)

For bearing and collar (eng .side



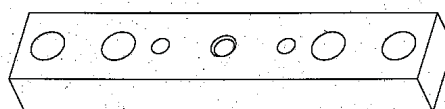
THRUST COLLAR EXTRACTOR (Parts No.177524-09380)

For collar (prop .side



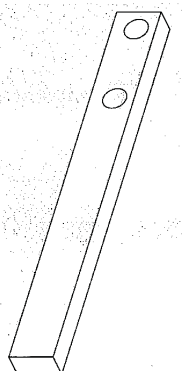
ARM (Parts No.177524-09230)

For disassembly of shaft assembly



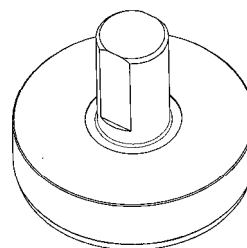
Wrench (Parts No.177523-09160)

for output coupling



Master-Case B (Output shaft) (Parts No.177524-09550)

for shim adjustment of output shaft assembly

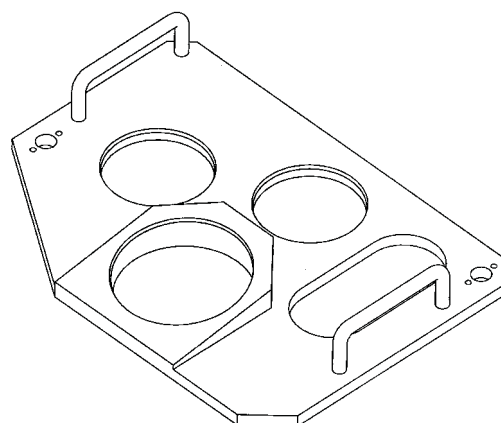
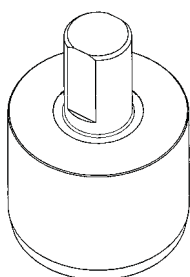


Master-Case A (Parts No.177523-09610)

for shim adjustment of case A

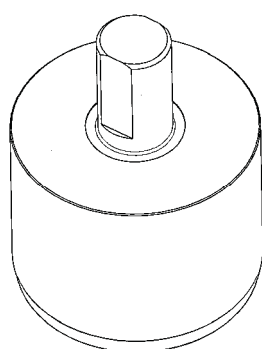
Master-Case A (Input shaft) (Parts No.177523-09510)

for shim adjustment of input shaft and support shaft assembly



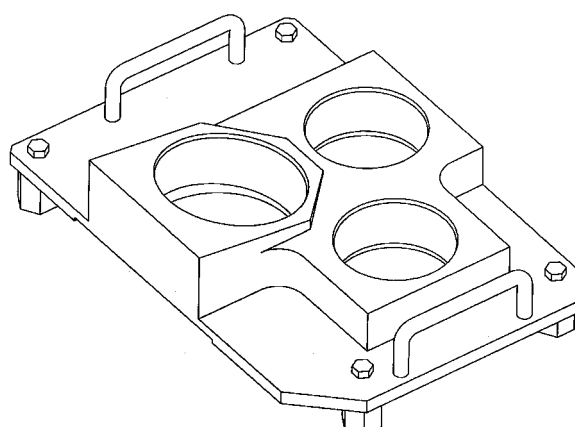
Master-Case A (Output shaft) (Parts No.177524-09520)

for shim adjustment of output shaft assembly



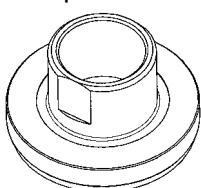
Master-Case B (Parts No.177523-09630)

for shim adjustment of case B



Master-Case B (Input shaft) (Parts No.177523-09560)

for shim adjustment of input shaft assembly



3.4. Disassembly

Introduction

Clean the transmission thoroughly on the outside before disassembly.

The repair area should be clean and well lighted.

3.4.1. Oil strainer

(1) Draining transmission oil

Unscrew drain plug (M16) with seal and remove the oil.(Fig. 1-1 item 1)

Drain into clean container for oil inspection.

Check seal for damage. Replace if necessary.

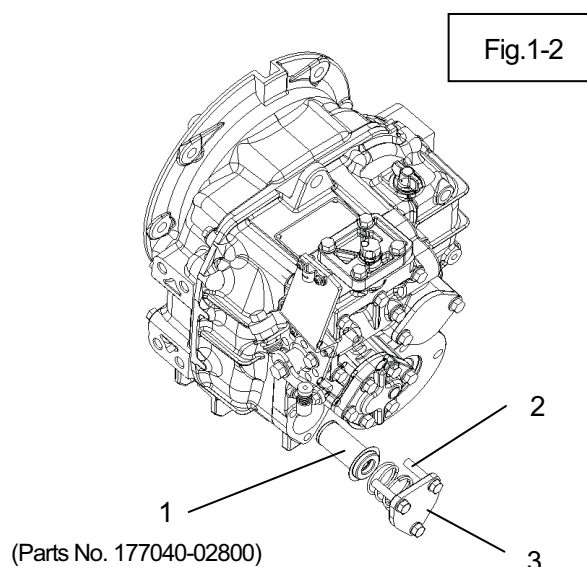
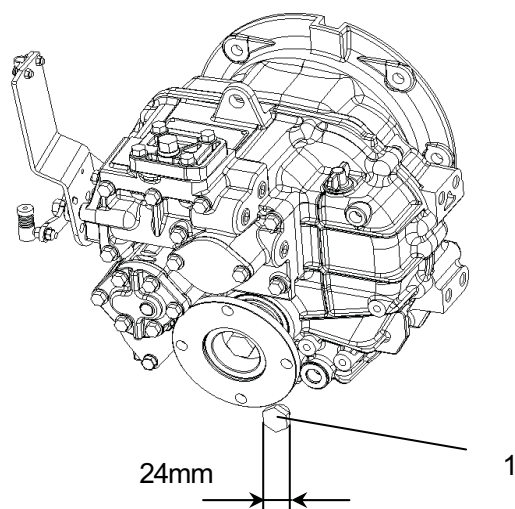


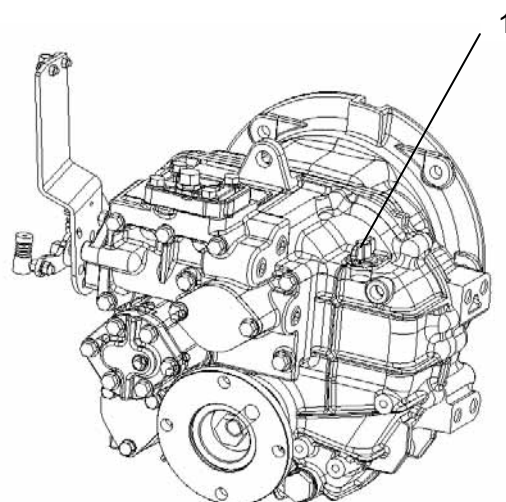
Fig.1-1



3.4.2. Removal dipstick

Extract dipstick (Fig. 2-1, item 1).

Fig.2-1



(2) Remove oil strainer

Unscrew three M8x40 bolts (Fig.1-2 item 2) and remove them together with washers.

Pull cover (Fig.1-2 item 3), seal, strainer element off.

Check seal for damage and strainer for wear. Replace if necessary.

The oil strainer (Fig.1-2 item 1) must be washed with clean oil whenever the oil is changed.

3.4.3. Output flange

Lock output flange in swivel flame.

Unscrew Hex head bolt (Fig. 3-1, item1)

Remove spacer(Fig.3-2, item1) and O-ring (Fig.3-2 item2)

Place extractor on the transmission and pull out the flange (Fig. 3-3, item1).

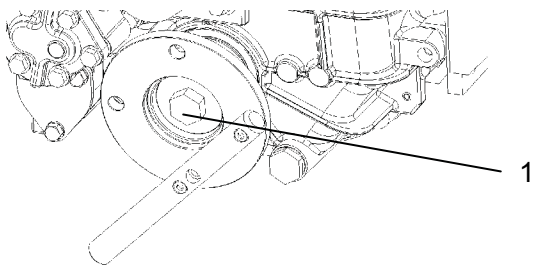


Fig.3-1

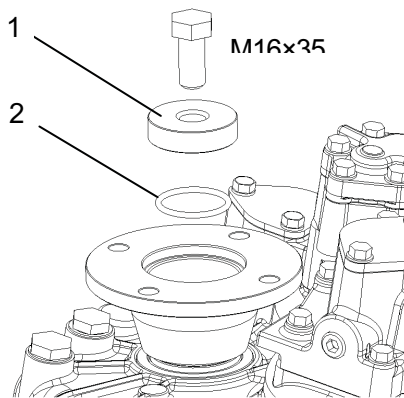


Fig.3-2

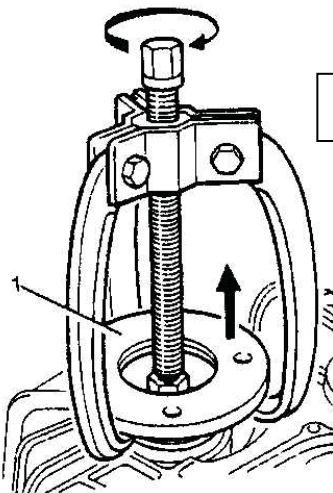


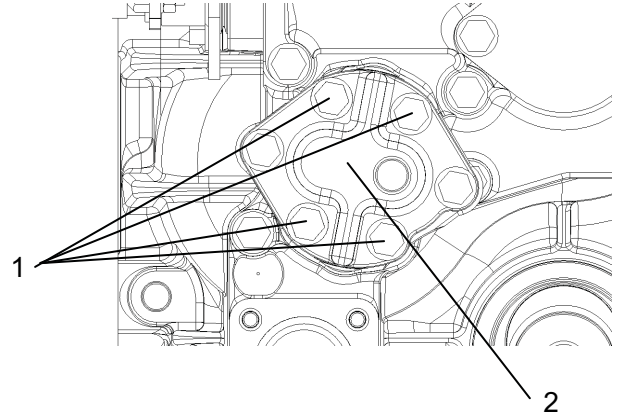
Fig.3-3

3.4.4. Oil pump removal

Unscrew hex head bolts (Fig. 4-1, item1).

Remove oil pump (Fig. 4-1, item2)

Fig.4-1



3.4.5. Case plate removal

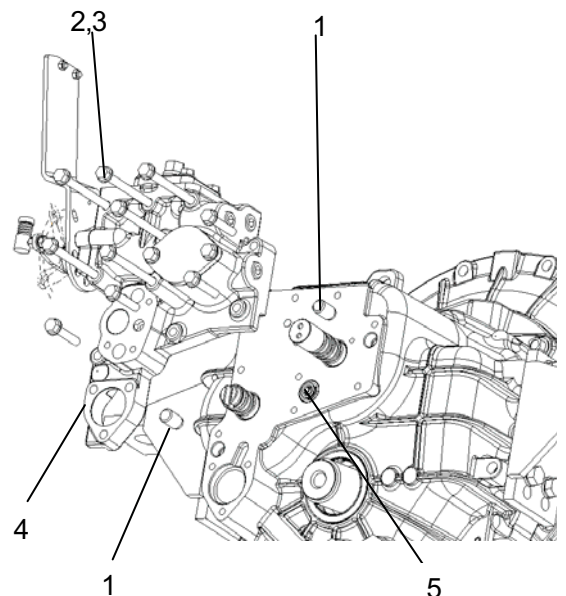
Loosen and remove all hex head bolts and lock washers (Fig. 5-1, item2 and 3).

Using a plastic hammer lightly tap the split line of the case plate surface to break the seal.

Pull case plate (Fig. 5-1, item4) and lubricating pressure relief valve (Fig. 5-1, item5).

Remove locating pins (Fig. 5-1, item 1)

Fig. 5-1

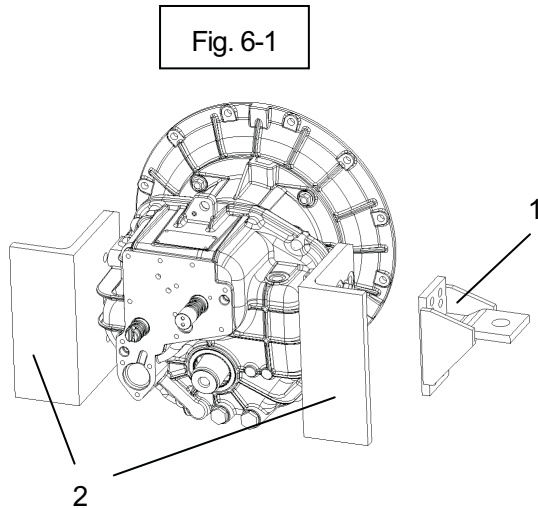


3.4.6. HOUSING

(1) Remove the foot

Remove the foot (Fig.6-1,item1)

Install the repair stand(Fig.6-1,item2)



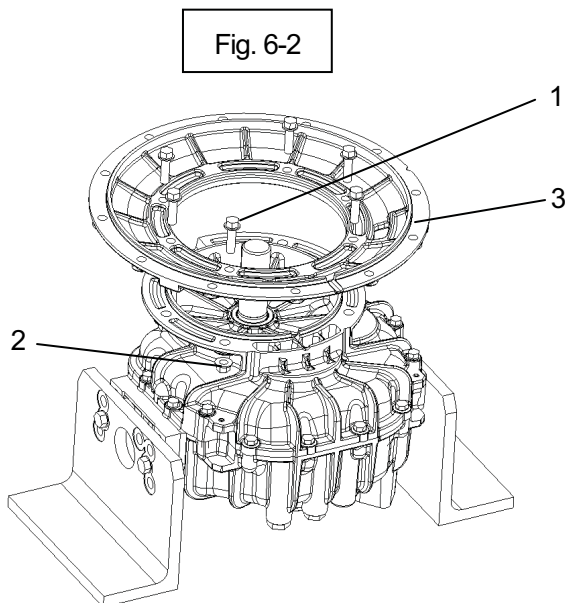
(2) Remove bell housing

Remove six M10×35 hex head bolts

(Figure 4-15,(1))and nuts(Figure 4-15,(2))
with 14mm socket wrench.

2.Remove mounting flange.(Figure4-15,(3))

(The flange is not attached to the model TTM50A -A7)

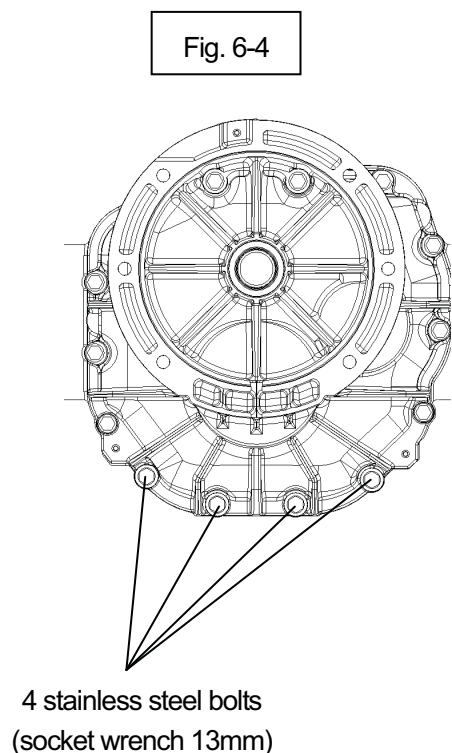
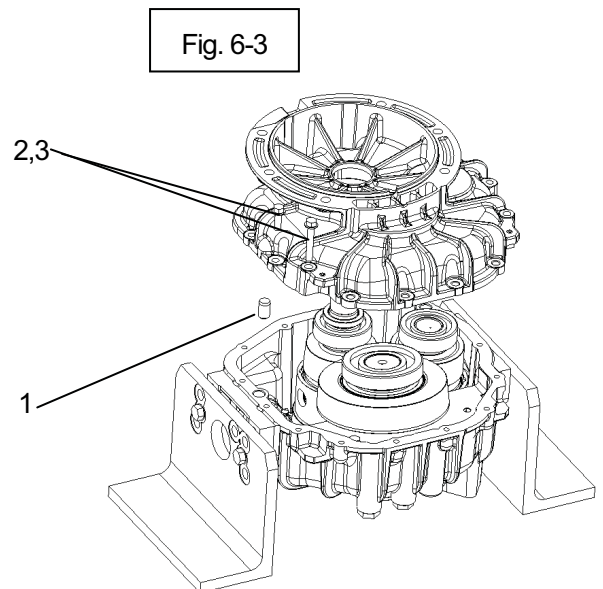


(3) Disassemble the transmission housing halves

Loosen and removal all hex bolts and lock washers (Fig. 6-3, item 2 and 3).

Note the two recessed bolts near input shaft and the four stainless steel bolts at the housing below(Fig. 6-4). Lightly tap the housing with plastic hammer. Prying with sharp tools can result in damage to sealing surface, leakage of oil, and failure of gear.

Remove locating pins (Fig. 6-3, item 1)



(4) Removal of shafts and gears

Take the gear set out of the housing.

- Input shaft (Fig. 6-5, item1).
- Support shaft (Fig. 6-5, item2)
- Output shaft (Fig. 6-5, item3)

Check all gears, bearings, piston rings on the input shaft and support shaft (Fig. 6-5, item 4 and 5) for signs of wear or failure.

If any of the gears are damaged or showing signs of excessive wear KANZAKI recommends replacing the complete gear set.

To check for correct clutch operation, rotate the gears on the input shaft.

Inspect clutch for excessive wear, replace clutch as required by feeling of smooth rotating only.

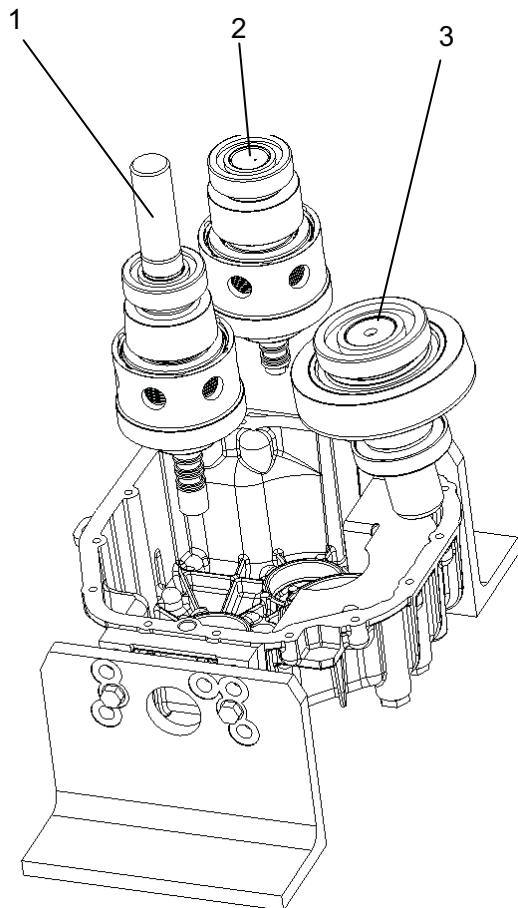


Fig.6-5

(5) Removal of radial oil seals

Input oil seal

Discard seal and replace with a new seal (Fig.6-6, item1).

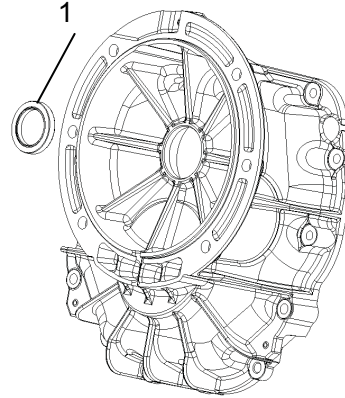


Fig. 6-6

Output oil seal

Discard seal and replace with a new seal(Fig.6-7, item1).

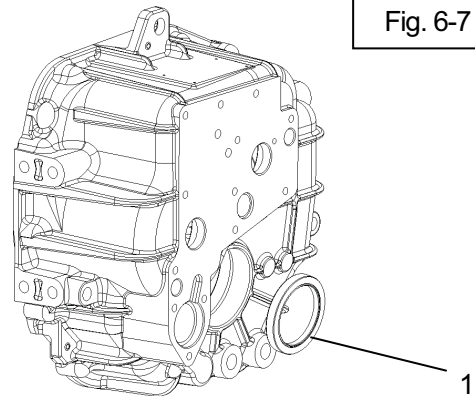


Fig. 6-7

(6) Removal of baffle and oil suction cover

Take the baffle and the suction cover out of the housing (Fig.6-8, item1 and 2).

Keep any dirt out of housing.

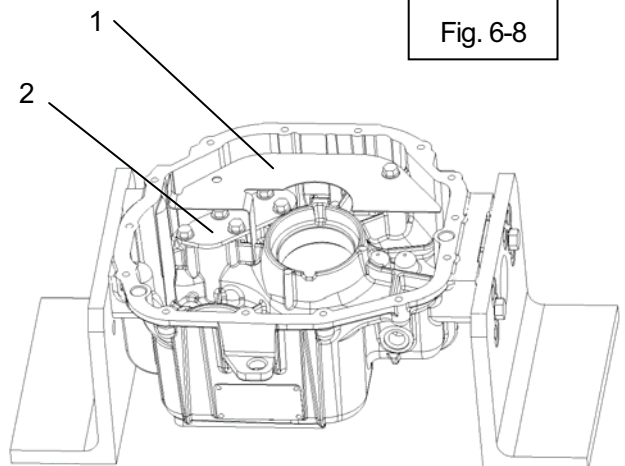


Fig. 6-8

3.4.7. Tapered roller bearings

Check for failed bearings or excessive bearing wear.

(1) Disassembling the outer races of tapered roller bearings

Remove the outer races out of housing halves by heating the housing halves in an oven to approx.120°C (250 °F):Put the housing in the oven upside down, so the races will fall out.

[Notice]

- Housing can be heated up by using other way (torch, heat gun etc)
- Make sure to keep the shims with each outer race and not mix them together.

⚠ WARNING

Use protective gloves when handing the heated housing and outer races.

(2) Removal of inner races of tapered roller bearings

Input shaft and support shaft - engine side

Remove the inner races of tapered roller bearing with thrust collar by bearing extractor (Fig. 7-1, item1) along with the arm and threaded rod M16×600(Fig.7-1, item2).

Make sure you pull on the thrust collar not on the bearing. Make sure the direction of thrust collar which is mounted to the shaft.

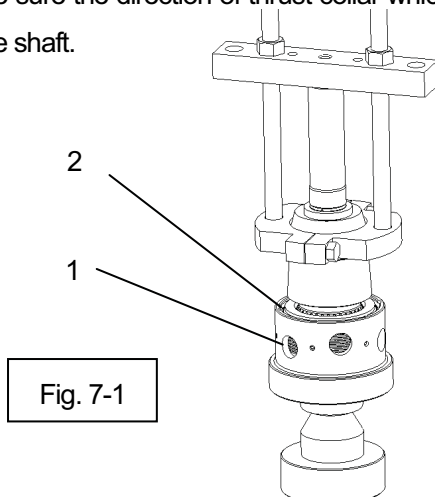


Fig. 7-1

Input shaft and support shaft - propeller side

Do not disassemble the shaft and housing of piston.

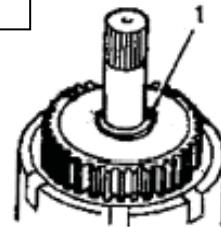
If the bearings are damaged, replace the complete bearing set.

3.4.8. Clutch pack

(1) Removal of the clutch disks

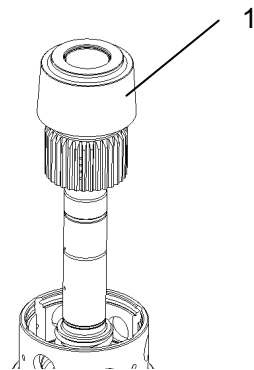
Remove retaining ring. (Fig. 8-1, item1).

Fig. 8-1



Remove Pinion Gear Assembly (Fig. 8-2, item1) .

Fig. 8-2



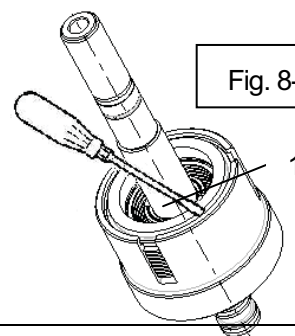
Remove retaining ring with pointed object (Fig. 8-3).

Removal pressure plate(Fig. 8-3, item 1).

The discs can now be removed from the housing.

Repeat same procedure to remove pressure plate on the support shaft.

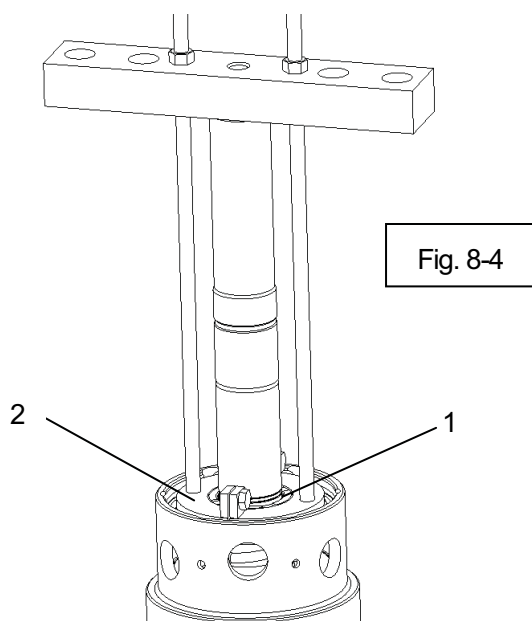
Fig. 8-3



(2) Removal of the clutch pistons

Remove the thrust collar (Fig. 8-4, item1) by the extractor. (Fig. 8-4, item2)

Note the direction of thrust collar which is mounted to the shaft.

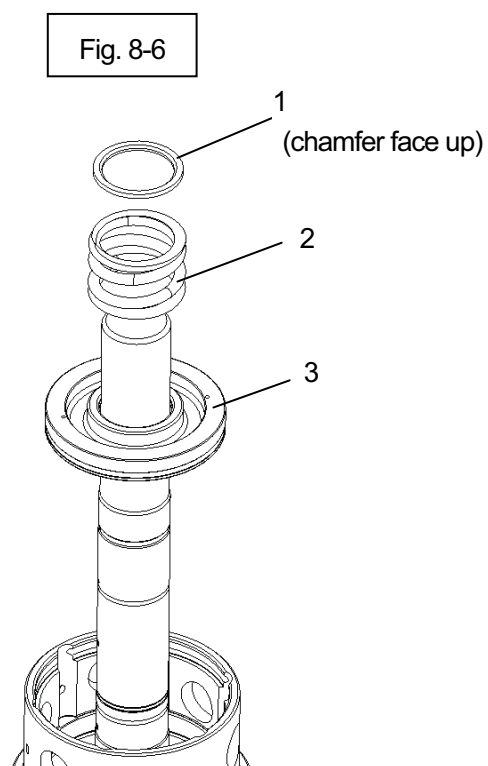


Take off retainer ring and spring (Fig. 8-6, item1 and 2).

Remove piston (Fig. 8-6, item3)

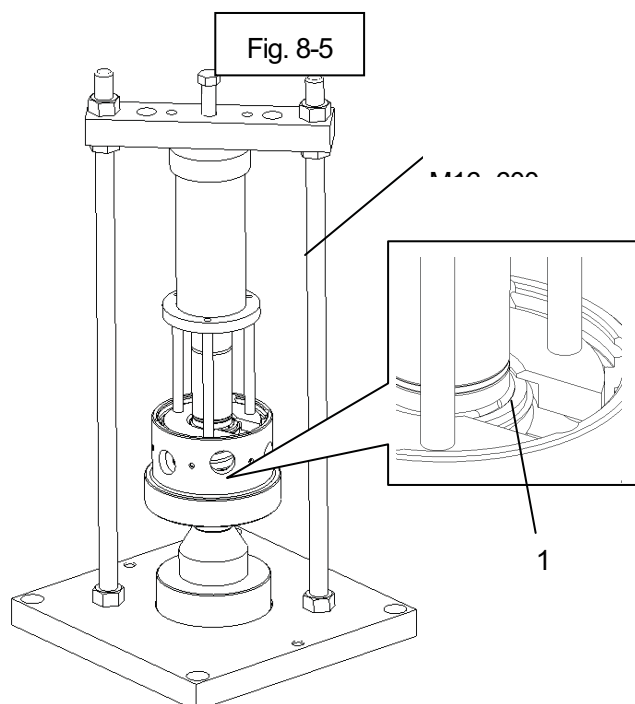
This may require application of low pressure air to opening in end of shaft.

Note the direction of retainer ring which is mounted to the shaft.



Compress spring using Spring Pusher, max 5 mm. compression (Fig 8-5, item 1).

Remove retainer ring.



3.5. Assembly

Introduction

A well-lighted work area that is free from dirt and debris, will facilitate the work considerably.

Clean and inspect all parts, install new seals.

Clean housing mating faces.

⚠ WARNING

Cleaners and solvents can be toxic and potentially harmful without proper ventilation. Use caution when using such cleaners.

Always wear protective gloves and glasses!

The next assembly procedure requires the following:

- An electric oven or heat gun or heating lamp for heating the housing halves will be required when mounting the bearings.
- A hydraulic or mechanical press.

3.5.1. Input shaft and support shaft

(1) Mount discs into clutch housing

Install O-rings (2) on piston by lubricating, take care not to stretch O-rings.

Install piston into clutch housing, being careful not to damage O-rings. Install return spring and retainer ring, pressing down with return spring compression tool. Locking ring should click into second groove.

Install steel plates and fiber disks(Fig.11-1, item 1,2), pre-lube all parts, begin and end with steel plate.

Notice : Plate and discs doesn't have direction ,but the retainer ring should be mounted only one direction that the chamfer surface is up side.

[Notice]

For exact quantity of inner and outer disks, please refer to the PARTS CATALOG.

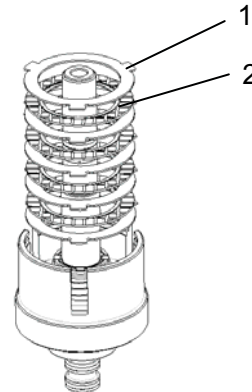


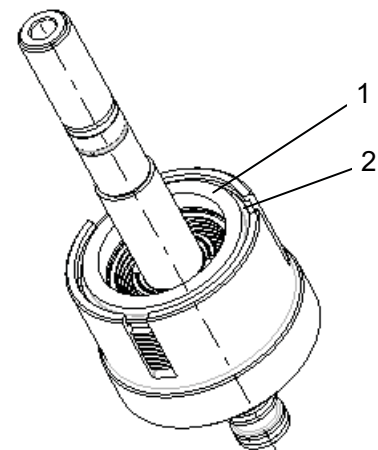
Fig. 11-1



	mm(in.)	
Stepped wear	Standard	Limit
Fiber disk t	1.65-1.75 (0.065-0.069)	1.55 (0.061)

Install pressure plate and retainer ring into groove making sure ring is seated, chamfer facing up (Fig. 11-2, item 1,2). check for pressure plate alignment and full engagement

Fig. 11-2



Repeat same procedure on support shaft.

(2) Install gears

Install clutch gear assembly (Fig. 11-3, item1).

Mount locking ring (Fig. 11-3, item2)

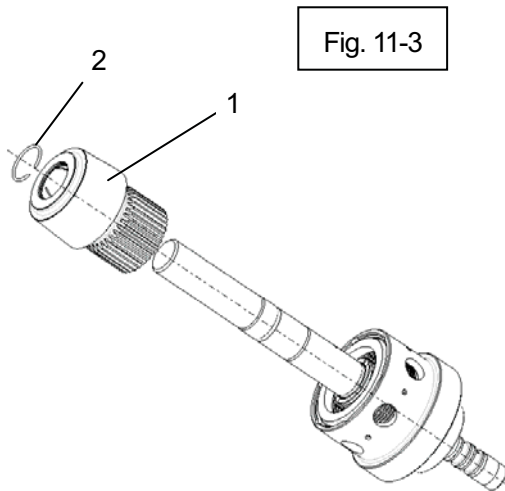
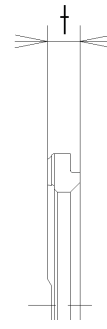
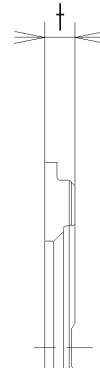


Fig. 11-3

engine side

propeller side



mm(in.)

Stepped wear	Standard	Limit
engine side t	4.90-5.00 (0.193-0.197)	4.70 (0.185)
propeller side t	4.90-5.00 (0.193-0.197)	4.70 (0.185)

Repeat same procedure on support shaft.

(3) Assemble thrust collars

Heat thrust collars and place onto shaft (120°C{250°F})

(Fig. 11-4, item1).

[Notice]

Make sure thrust collars are fully pressed on and have a clearance of 0.25 to 1.05 mm between thrust collars and top of pinion gear.

Thrust collars must not be bent.

Note the direction of thrust collar which is mounted to the shaft. The thrust collar of engine side must be mounted lining face-down and the one of propeller side must be mounted to lining face-up.

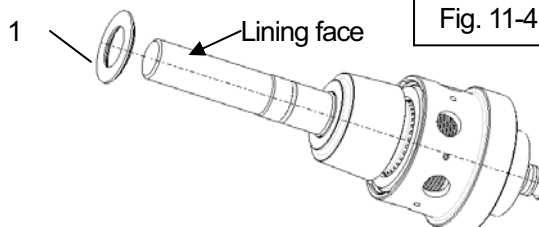


Fig. 11-4

(4) Re-install tapered roller bearings

Heat inner race of tapered bearing (Fig. 11-5, item 1) to approx. 120°C(250°F) and push it onto the shaft up against thrust collar (Fig. 11-5, item 2).

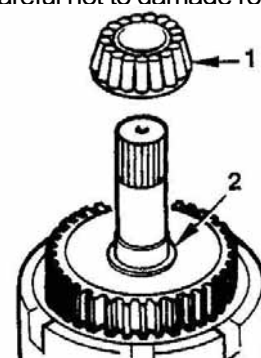
⚠ WARNING

Handle heated tapered roller bearing with heat resistant gloves!

[Notice]

If pressing, be careful not to damage roller cage.

Fig. 11-5



(5) Assemble seal rings

Install seal rings (Fig. 11-6, item1) onto input shaft and support shaft.

Lubricate by grease (common type) for ease installation.

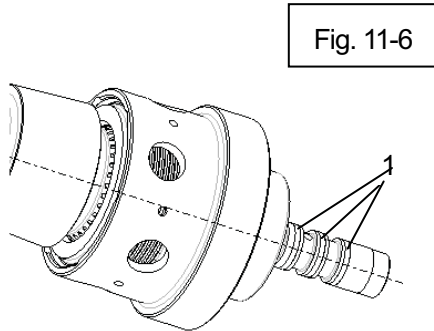


Fig. 11-6

3.5.2. Output shaft

(1) If previously removed, re-install tapered roller bearing

Heat inner race of tapered bearing (Fig. 12-1, item 1 and 2) to approx. 120°C(250°F) and push them onto output shaft up against shaft collar.

⚠ WARNING

Handle heated tapered roller bearing with heat resistant gloves!

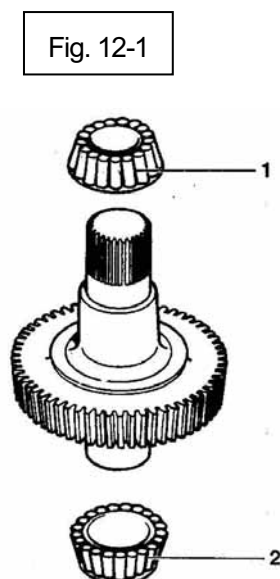


Fig. 12-1

3.5.3. Gear backlash adjustment

This procedure is required only when a gear ratio is changed.

[Notice]

The shim of propeller side is for adjusting gear backlash.
The shim of engine side is for adjusting bearing side clearance.

A shim here is former one.

Gear backlash must be adjusted as following procedure.

- (1) Insert the input shaft assembly in case B with shim 0.9mm behind the outer race of bearing (Fig.13-1, item1).
- (2) Insert the support shaft assembly in case B (Shim is not needed) (Fig. 13-1, item2)
- (3) Insert the output shaft assembly in case B with shim 0.9mm behind the outer race of bearing (Fig.13-1, item3).
- (4)Set the special tool (Fig. 13-2, item1) and insert the outer race of bearings into individual shafts (Fig.13-2, item2).
- (5)Set the dial gauge on case B and let pick up touch on input pinion or support pinion. Rotate them lightly and measure the backlash between output gear and input pinion, output gear and support pinion (backlash standard 0.08-0.16mm) (Fig.13-2).

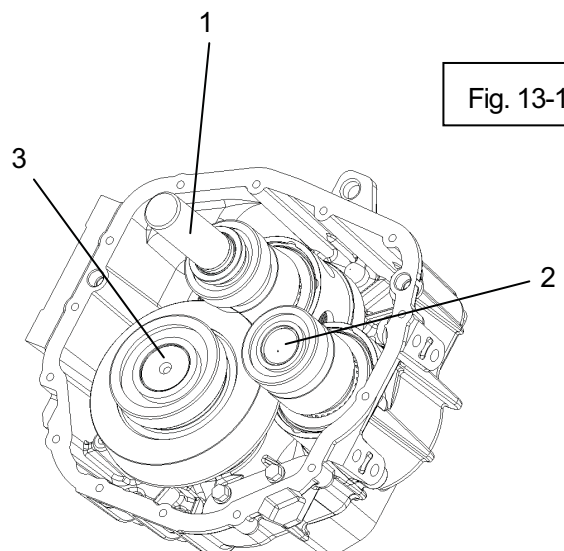
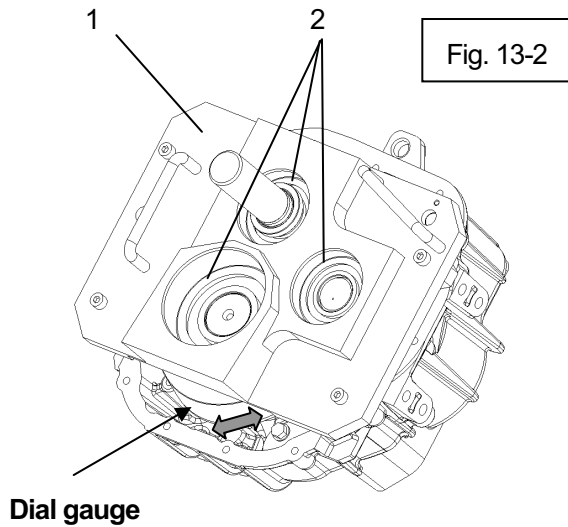


Fig. 13-1



- ① If backlash is 0.08-0.16mm, GO TO (6).
- ② If backlash is under 0.08mm, reduce the shim of the input shaft.
Whenever reduce the shim by 0.1mm, a backlash increases by 0.008mm.
- ③ If backlash is over 0.16mm, add the shim of the output shaft
Whenever add the shim by 0.1mm, a backlash decreases by 0.008mm

Note: the backlash measurement between output gear and support pinion is only for confirmation because that value is determined by parts accuracy and can not be adjusted.

- (6) Once take out the output shaft assembly and insert it again into case B with baffle plate.

3.5.4. Preassembly of housing

(1) Assembly of outer races (tapered roller bearings)

Heat half of the housing (output side of case) in an oven

or other way to approx. 120°C(250°F), or cool outer races with dry ice or liquid nitrogen.

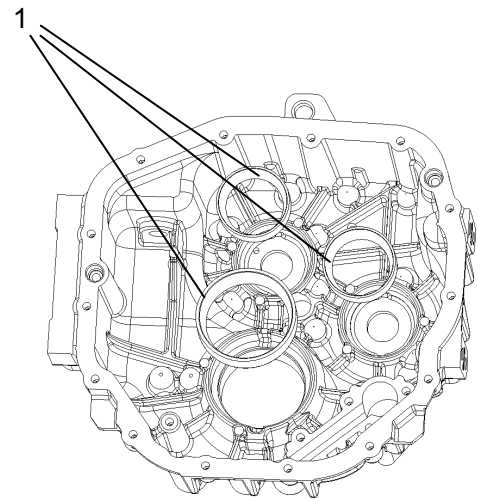
Insert outer races (Fig. 14-1, item1) into housing.

Note: Housing can be heated up by using other way (torch, heat gun etc)

⚠ WARNING

Handle heated tapered roller bearings outer races only with protective gloves.

Fig. 14-1



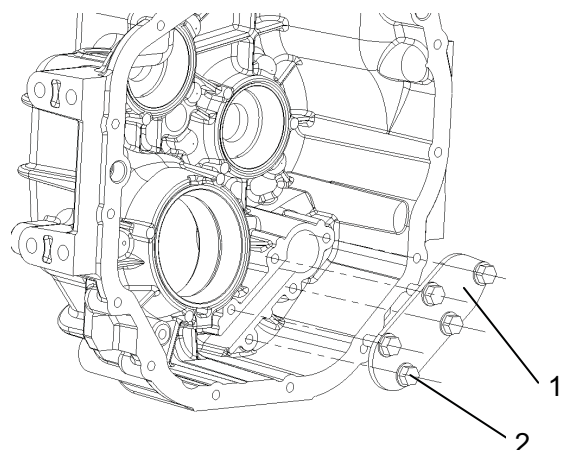
(2) Installation of oil suction cover

Insert suction cover (Fig. 14-2, item 1) into housing.

Apply a thin coat of Three bond 1215 (or equivalent) on housing face.

Lock suction cover in place by screwing in bolts (Fig. 14-2 item 2)

Fig. 14-2

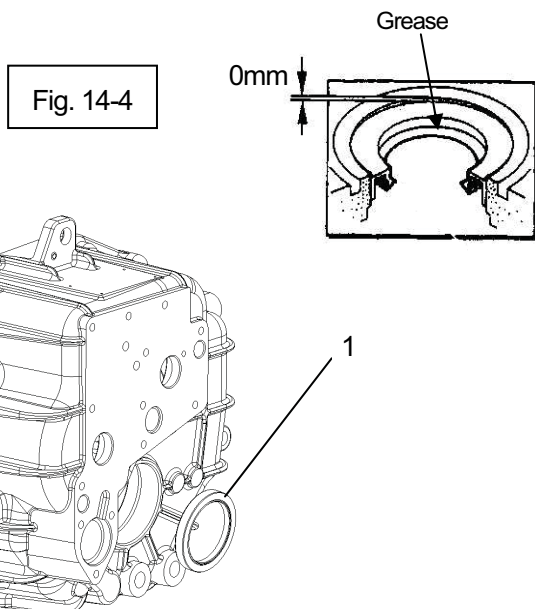
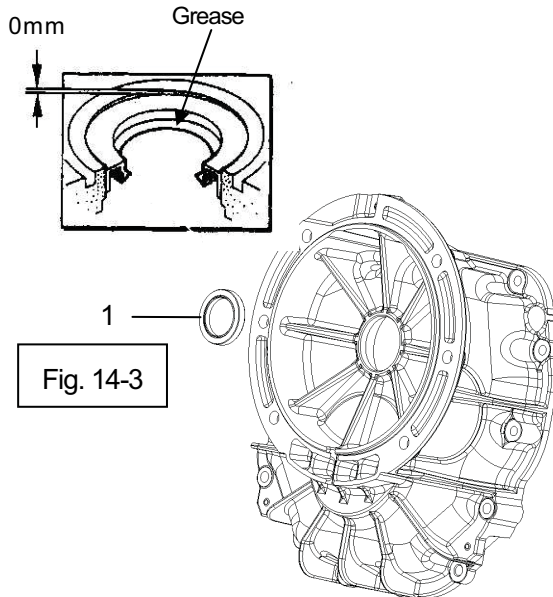


(3) Installation of baffle

Position baffle plate into housing by aligning tabs.

(4) Assemble shaft seal rings

Apply lips of seal rings (Fig. 14-3 and 14-4, item1) with Shell Alvania Grease or equivalent.



3.5.5. Measuring the bearing clearance/ adjusting the preload of bearings

(1) General

This procedure is required when a gear ratio or the shaft

assembly is changed.

The required preload / play of bearings of the individual shafts in the housing is obtained by using shims of different thickness under the outer races of the roller bearings.

Shims which have been removed during disassembly may be reused.

First adjustment must refer to bearing clearance.

Preload/Play (mm)

input	support	Output
0.05 preload	0.05 preload	0.20 preload
~	~	~
0.05 play	0.05 play	0.10 preload

(2) Bearing clearance adjustment

①Set the special tool (Fig.15-1, item1,2,3 and 4) on case A.

②Measure the depth A of individual master (Fig.15-1, item 5) by dial gauge.

③Set the special tool (Fig.15-2, item1,2,3 and 4) on case B.

④Measure the depth B of individual master (Fig.15-2, item 5) by dial gauge.

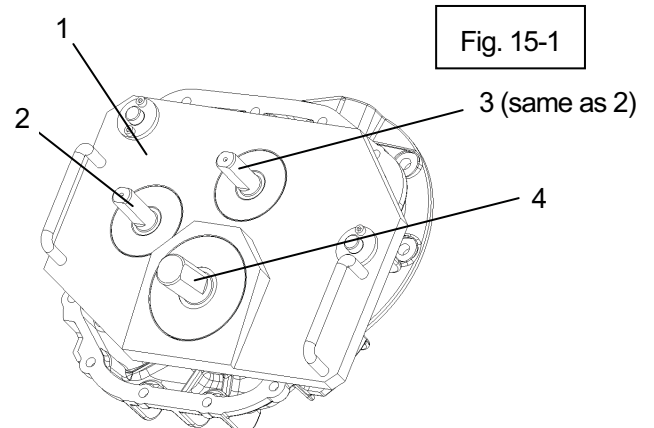
⑤Calculate the thickness T of individual shims by the

following formula. Select and set the thickness of individual shims based on the below calculation.

$$\text{Input shaft} \quad T_{in} = A_{in} + B_{in} \pm 0.05$$

$$\text{Support shaft} \quad T_{sup} = A_{sup} + B_{sup} \pm 0.05$$

$$\text{Output shaft} \quad T_{out} = A_{out} + B_{out} + (0-0.1)$$



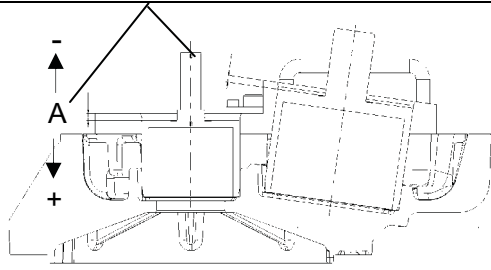


Fig. 15-2

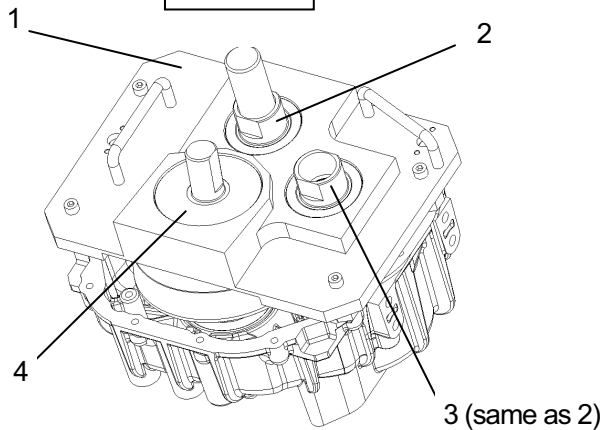


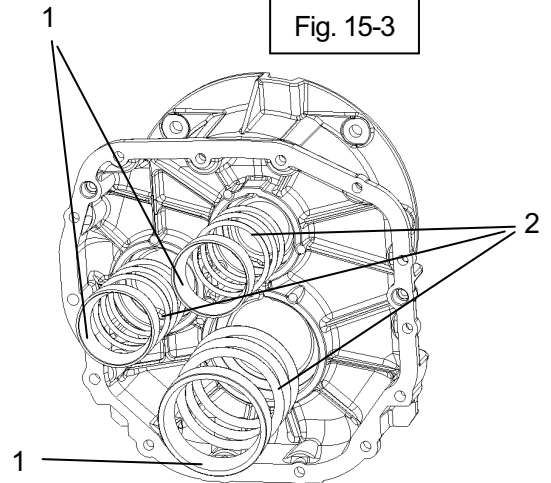
Fig. 15-3

thickness of shims (Fig. 15-3, item 2).

Heat half of the housing (engine side case) in an oven or other way to approx. 120°C (250°F) or cool outer races with dry ice or liquid nitrogen.

Insert shims and outer races (Fig. 15-3, item 1) of bearings into the housing.

When housing has cooled down to ambient temperature, press outer races carefully down using a copper/brass punch.



(5) Final assembly of the housing

- Install baffle (Fig. 15-4, item 1).
- Fill space between seal and dust lips of shaft seal rings with a high quality bearing grease (Shell Alvania Grease or equivalent).
- Apply a thin coat of Three bond 1215 (or equivalent) on mating face of housing half (Fig. 15-4, item 2).
- Install locating pins (large chamfer needs to be up) into housing to align housing halves, before tightening (Fig. 15-4, item 3).

(3) Inserting gear set into housing

Install the baffle.

Clean housing mating face halves with an oilstone.

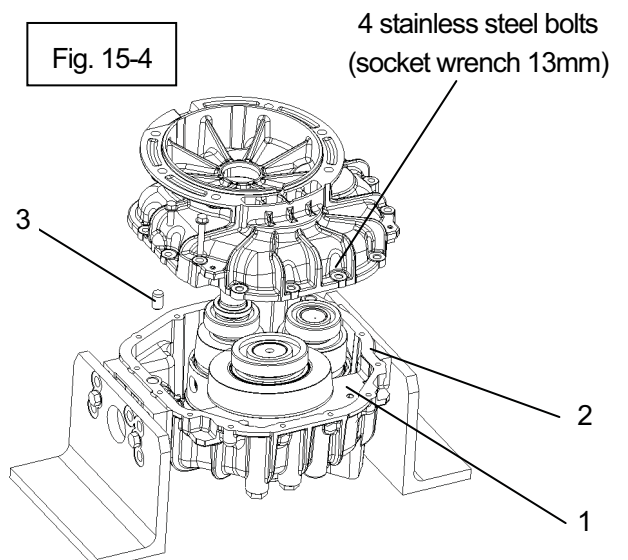


Make sure to keep any dirt out of housing.

(4) Re-install outer races of tapered roller bearings into housing

The bearing clearance measured the preload / play required in step 3.5.5.(1) will determine the required

Fig. 15-4



3.5.6. Case plate

(1) Mounting the case plate

New seal rings have already been assembled according to section 3.5.1(5).

Remove repair stand, install the foot.

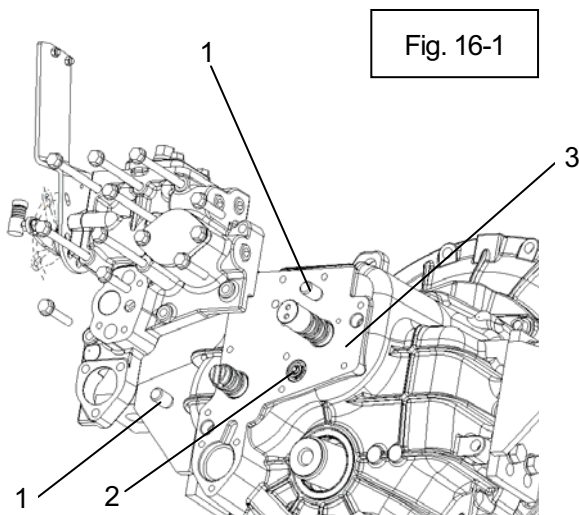
Install locating pins (large chamfer needs to be up) (Fig. 16-1,item 1) into the case plate.

Place lubricating pressure relief (Fig. 16-1,item2) valve on housing.

Replace gasket (Fig. 16-1 item3) on housing.

Slide case plate carefully on two shafts.

Attach bolts and torque to specifications outlined in Chapter 5: Tightening Torques.



3.5.8. Output flange

Remove O-ring before heating flange.

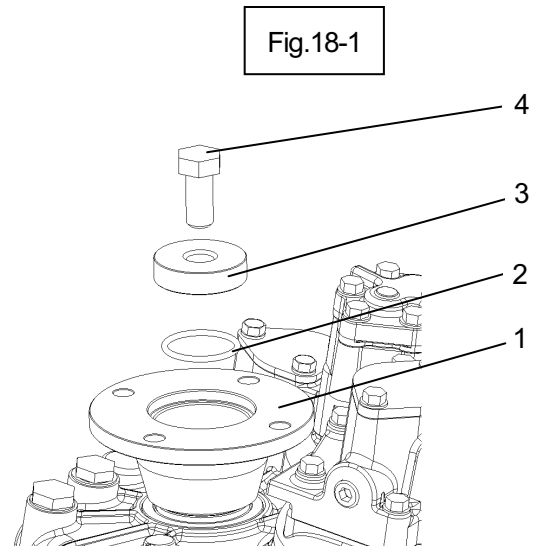
Heat output flange to 120°C (250°F) (Fig.18-1,item1).

Drive flange onto shaft without O-ring using bolt (Fig.18-1, item 4)

Lubricate O-ring (Fig.18-1, item2) with grease and insert into output flange.

Tighten output flange down on output shaft with bolt (Fig. 17-1,item4) and spacer (Fig. 18-1,item3).

Add anti-seize compound to bolt and tighten to torque: 235-215 Nm



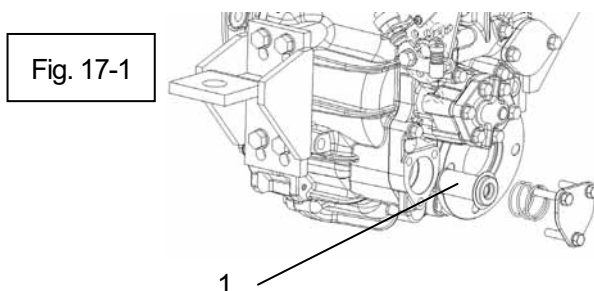
3.5.7. Oil strainer

(1) Mounting the oil strainer

Check seal for damage and strainer for wear. Replace if necessary.

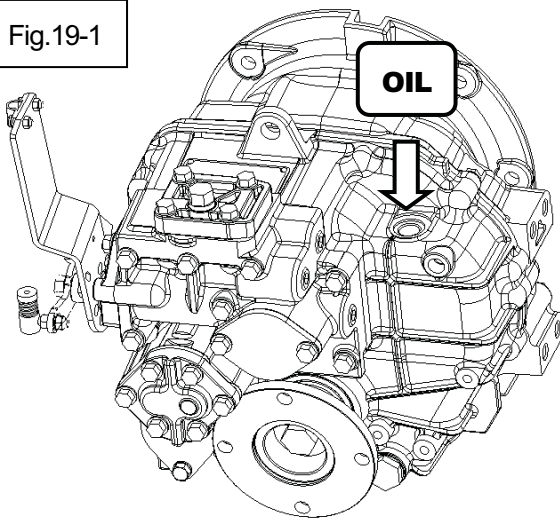
The oil strainer(Fig.17-1, item 1)must be washed with clean oil whenever the oil is changed.

Install strainer, spring, gasket, and cover plate with bolts.



3.5.9. Making the transmission ready for operation

Fig.19-1



(1) Filling up with SAE 30 oil

Filling with SAE 30 oil into the dipstick opening.(Fig.19-1)

Capacity : 2,0 liters. (effective)

Type of oil: see chapter 7.

(2) Check oil level

Extract dipstick (Fig. 19-2, item 1).

- (1) Wipe dipstick with a dust-free cloth.
- (2) Insert dipstick.
- (3) Remove dipstick and check oil level (Fig. 19-3) : Oil level has to be between minimum and maximum marks.

Fig.19-2

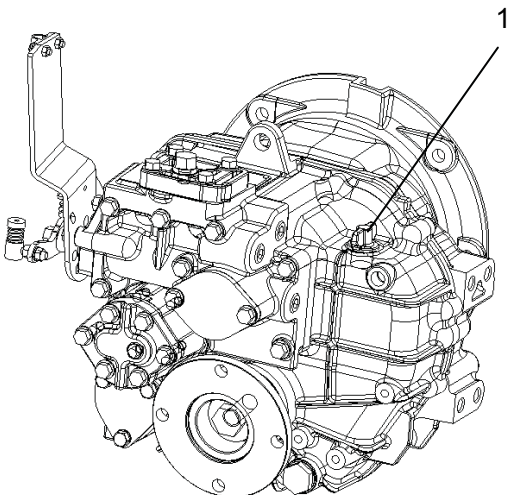
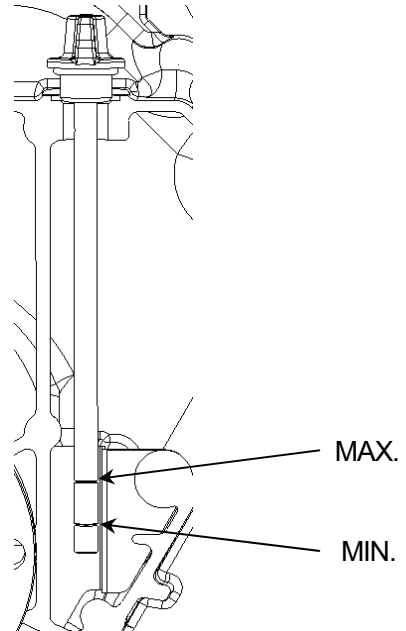


Fig.19-3



(3) Trial run

Carry out a trial run after the oil filling.

Set shifting lever to neutral position(N). Start engine and let it run idle for a short time to fill the cooler and pipelines with SAE 30 oil.

Stop the engine and check oil level again. If necessary, replenish with oil. Excessive oil should be removed.

The oil level on the dipstick (Fig.19-3) should be between the min. and max. marks .

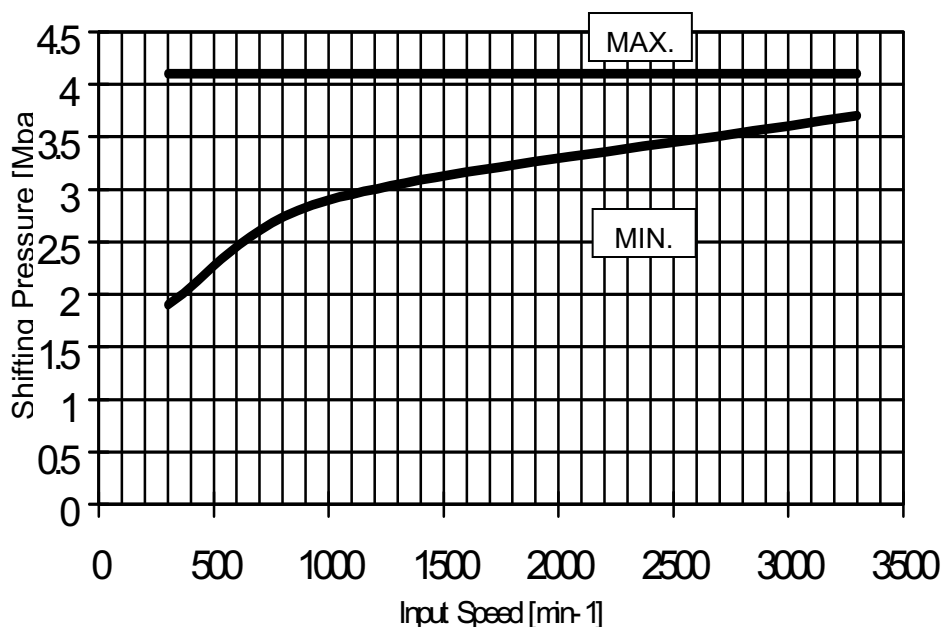
The oil level should be checked again after a short running period.

See chapter 6. regarding function test with measuring instruments required and Tests to be carried out:

4. Adjustment data

(1) Shifting pressure

Shifting pressure is hydraulic pressure. Shifting pressure must be between min. and max. line in the below performance graph at any time. If not so, see troubleshooting in chapter 8.



5. Tightening torques

Item	size	Tightening torques
Transmission assembly bolts	M8	18.6-22.6 Nm
	M10	37.2-41.2 Nm
	M12	65.7-75.5 Nm
Output flange bolt	M20	215 –235 Nm
Dipstick		Hand tight
Breather		Hand tight

6. Function test

When the transmission has been completely assembled and filled up with oil, it would be convenient to make a function test.

This test can be carried out on a bench test rig, or in a boat.

If no oil cooler can be connected, a hydraulic hose must be connected between the inlet and outlet of the hydraulic pump.

Measuring instruments required:

- Pressure gauge 0-5 MPa (0 - 750 psi), with connecting thread M10x1.25.
- Temperature gauge 0-120°C(0 – 250°F), connecting thread 3/8"-18NPTF.

The position to be mounted the pressure gauge(hydraulic/lubrication oil): see chapter 2.4.(Hydraulic diagram)

Tests to be carried out:

1. Fluid leaks
2. Noise emission
3. Direction of rotation, LH/RH
4. Lube oil temperature
5. Shifting pressure
6. Neutral performance
7. Shifting performance

The function test should be carried out follows:

No.	Motor speed min ⁻¹	Shift lever position A: Lever is raised B: Lever is lowered	Durat. minutes	Test
1	800 - 1000	neutral	5	1,2
2	600 - 800 (idling speed)	A<->B position repeatedly	-	1,2,3,6,7
3	1500 - 2500	B position	*	1,2,4
4	600 - 800 (idling speed)	A<->B position repeatedly	-	1,2,3,6,7
5	idling – max. speed	A position	-	1,2,5**
6	600 - 800 (idling speed)	A->B position	-	1,2
7	Idling – max. speed	B position	-	1,2,5**

*Until oil temperature of 75-80°C has been reached.

**At different speeds.

Note: see chapter 4(1) Shifting pressure and the below standard value.

Standard value of performance

ITEMS				SPECIFICATION	REMARKS
NEUTRAL PERFORMANCE (TIME UNTILL SELF-STOPPING)			s	≤20	Oil temp. 30°C Idling speed
SHIFTING	TIME TO ENGAGE.		s	≤1.0	Oil temp. 30°C Idling speed
OIL TEMPERATURE			°C	≤90	
OIL PRESS.	HO	MAX.	MPa	≤4.09	Oil temp. 30°C , 3300min ⁻¹
		SETTING	MPa	3.72±0.05	Oil temp. 60°C , 3300min ⁻¹

Service Manual TTM50A-A7					
	LO	MIN.	MPa	≥ 1.86	Oil temp. 60°C , 700min ⁻¹
		MAX.	MPa	≤ 0.30	Oil temp. 30°C , 3300min ⁻¹
		SETTING	MPa	0.25±0.05	Oil temp. 60°C , 3300min ⁻¹
		MIN.	MPa	≥ 0.01	Oil temp. 60°C , 700min ⁻¹

7. Recommended oil

(1) Type of oil

API (American Petroleum Institute) service grade: class CC or CF.

Viscosity: SAE 30

[Notice]

Do not use multi-grade oil and the mixed oils. The single-grade oil must be used.

8. Troubleshooting

In case of trouble, check first whether all items of the mounting and operating instructions have been completed with.

The subsequent tables will assist you troubleshooting.

No.	Problem	Possible cause	Countermeasure
1	Transmission cannot be shifted.	Shifting lever is loose.	Tighten clamping bolt on shifting lever.
		Remote control does not permit lever travel required for testing.	Lift remote control off, if gears can be shifted by hand, correct remote control.
		Remote control faulty	Repair remote control.
		No shifting pressure available	Refer to No.7.
2	Delayed shift time	Shift linkage misadjusted; not allowing full engagement.	Lift remote control off, if gear can be shifted by hand, correct remote control. If the transmission cannot be shifted correctly by hand, replace the control block.
3	Clutch is slipping, i.e. propeller speed too low as compared to engine speed.	Inadmissible oil used.	Drain oil, refill with prescribed oil, flush transmission while engine runs in neutral position, drain oil, refill transmission.
		Oil contains water.	Refer to No.9.
		Shifting pressure too low.	Refer to No.6.
		Wear on clutch disks.	Disassemble transmission, replace clutch disks.
		Piston rings in clutch are damaged.	Disassemble transmission, replace clutch.
4	Transmission locked in gear	Seal ring on input shaft or support shaft in case plate is faulty.	Remove case plate, replace seal ring, if case plate is worn, replace likewise.
		Warped disks due to overheating of slipping clutch.	Refer to No.3.
		Plain bearings on input or support shaft are worn out.	Disassembly transmission, repair if possible or use substitute transmission.

No.	Problem	Possible cause	Countermeasure
5	Output shaft turns in neutral position.	Rotary valve in casing is worn.	Replace rotary valve.
		Faulty plain bearing on input or support shaft.	Disassembly transmission and input or support shaft, replace bearing concerned and other damaged parts.
		Warped disks due to overheating of slipping clutch.	Refer to No.3.
6	Shifting pressure too low	Oil strainer clogged.	Wash strainer or replace fine one.
		Oil level in transmission.	Top-up with oil; In case of oil loss check transmission, cooler and pipelines for leakage and remedy same; also refer to No.10 through No.13.
		Oil pump is worn out	Replace oil pump.
		Spring in shifting pressure relief valve is broken.	Replace spring.
		Seal rings on input shaft or support shaft are faulty.	Remove case plate, replace seal ring, if case plate is worn, replace likewise.
		Throttle valve for shifting pressure is broken.	Replace throttle valve.
		Piston rings in clutch are faulty.	Disassemble transmission , replace clutch.
		choke port at modulator valve obstructed by contamination.	Wash the modulator valve.
7	No shifting pressure available	Direction of engine rotation does not agree with arrow on transmission.	Replace with engine of correct of rotation.
		No oil in the transmission.	Refill with oil.
		Strainer is dirty.	Replace fine strainer.
		Oil level in transmission is too low.	Top-up with oil; In case of oil loss check transmission, cooler and pipelines for leakage and remedy same; also refer to No.10 through No.13.
		Oil pump is worn out	Replace oil pump.
		Spring in shifting pressure relief valve is broken.	Replace spring.
		Throttle valve for shifting pressure is broken.	Replace throttle valve.

No.	Problem	Possible cause	Countermeasure
8	Excessive oil temperature	Excessive oil in transmission	Remove excessive oil with commercial suction pump.
		Oil cooler is dirty on water side.	Clean oil cooler on water side.
		Worn oil pump.	Replace oil pump.
		Seal rings on input shaft or support shaft are faulty.	Remove case plate, replace seal ring, if case plate is worn, replace likewise.
		Clutch is slipping.	Refer to No.3.
		Clutch does not open completely due to worn disc support.	Dismount transmission and coupling, replace inner disc support and / or clutch.
9	Water in the oil, oil looks milky.	Oil cooler faulty.	Repair leakage at cooler or replace cooler.
		High water level in engine compartment, water entering through output shaft seal.	Remedy cause for water level in engine compartment change transmission.
10	Oil leakage at output shaft.	Breather clogged with paint or dirt.	Remove paint or dirt from breather.
		Shaft seal faulty.	Disassemble transmission, replace seal. If seal location on output shaft is worn-seal lip should be mounted offset.
11	Oil leakage at breather.	Excessive oil in transmission	Pump excessive oil out.
12	Oil leakage at joints.	Bolts are not tight.	Tighten bolts with prescribed torque.
		Seals on bolts have been	Replace seals, tighten bolts used several times with prescribed torque.
		Mating faces are contaminated, no surface seal applied.	Unscrew housing half, finish mating faces with oilstone or finishing file, apply surface seal. Assemble transmission, tighten bolts with prescribed torque.

No.	Problem	Possible cause	Countermeasure
13	Transmission noise becomes louder.	Oil level too low so that pump sucks in air.	Top up with oil to marking on dipstick.
		Damage starting on flexible coupling due to misalignment between engine and transmission.	Replace flexible coupling. Check alignment between engine and transmission.
		Beginning damage of bearings in transmission, e.g. due to torsional vibrations, running without oil, overload, wrong alignment of transmission excessive engine output.	Disassemble transmission, replace bearings concerned and other faulty parts. Find causes and remedy.
		Beginning damage of gearings, e.g. due to torsional vibrations, running without oil, overload.	Disassemble transmission, remove faulty parts.
		Oil suction cover in transmission has come loose.	Disassemble transmission, fix oil suction cover.
14	Chattering transmission noise mainly at low engine speed.	The engine or propeller generate torsional vibrations in the drive unit which produce a <<chattering>> noise in the transmission.	Mount a specified damper between engine and transmission (recommended damper : Type CF-R-136-011-61106-S2 by CENTA. Parts No.177524-03911). Otherwise analyze the torsional vibrations to find out the proper propeller shaft and propeller (refer to recommended propeller shaft and propeller in operation manual).
		Misaligned jack shafts on input or output.	Mount and align jack shaft strictly according to instructions issued by jack shaft manufacturer.

